DOCUMENT RESUME

ED 149 974 SE 023 425

TITLE	The National Academy of Engineering: The First Ten Years.
INSTITUTION	National Academy of Engineering, Washington, D.C.
PUB DATE	Nov 76
NOTE	270p.
EDRS PRICE	MF-$0.83 HC-$14.05 Plus Postage.
DESCRIPTORS	Engineering; *Engineering Technology; *Engineers; National Organizations; *Professional Associations; Science Education; *Science Institutes; Technical Occupations; *Technological Advancement; Technology
IDENTIFIERS	*National Academy of Engineering

ABSTRACT

This document is a synopsis of the National Academy of Engineering's (NAE) first ten years; its formation, development, and work. This document is not intended to serve as a definitive history of the NAE, but rather to outline its development and to introduce the Academy to the interested reader who may be unfamiliar with its work and to provide to those who need no such introduction an indicator of its accomplishments in its early years. In the largest of the three sections of this publication, the Appendices include membership list, advisory activities, joint activities with other professional organizations, publication list of NAE, and articles of organization and bylaws. (MR)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

Leila Von Meister
NAE

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC) AND USERS OF THE ERIC SYSTEM."

U S DEPARTMENT OF HEALTH
EDUCATION & WELFARE
NATIONAL INSTITUTE OF
EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

The National Academy of Engineering: The First Ten Years

2

THE NATIONAL ACADEMY OF ENGINEERING:

THE FIRST TEN YEARS

National Academy of Engineering
Washington, D.C.
November, 1976

FOUNDING MEMBERS

OF THE

NATIONAL ACADEMY OF ENGINEERING

Hendrik W. Bode*
Walker L. Cisler
Hugh L. Dryden
Elmer W. Engstrom
William L. Everitt
Antoine M. Gaudin
Michael L. Haider
George E. Holbrook
J. Herbert Hollomon
Thomas C. Kavanagh
Augustus B. Kinzel*
James N. Landis
Clarence H. Linder
Clark B. Millikan
Nathan M. Newmark*
William H. Pickering*
Simon Ramo
Arthur E. Raymond*
Thomas K. Sherwood*
Julius A. Stratton*
C. Guy Suits*
Frederick E. Terman*
Charles A. Thomas*
Eric A. Walker
Ernst Weber

*Member of the National Academy of Sciences at the time of the establishment of the National Academy of Engineering.

ACKNOWLEDGEMENTS

The tenth anniversary of the National Academy of Engineering occurred on December 5, 1974. Another milestone was reached a few months earlier, on July 1, when an agreement between the NAE and the National Academy of Sciences, setting forth principles for the joint governance of the National Research Council, was promulgated. It seemed timely, therefore, to prepare a commemorative volume which would document the early, formative years of the Academy of Engineering. The fourth President of the Academy, Robert C. Seamans, Jr., had evolved the concept and initiated the project with the endorsement of the governing Council of the Academy. It is perhaps also appropriate that completion of the work coincides with the nation's Bicentennial -- a period which lends itself to introspection and rededication.

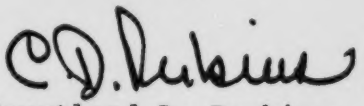
This document is not intended to serve as a definitive history of the NAE, but rather to outline its development -- to introduce the Academy to the interested reader who may be unfamiliar with its work, and to provide to those who need no such introduction, an indicator of its accomplishments in its early years.

The chairmen of many of the Academy's boards and committees contributed significantly to this publication through their review of the descriptions of the technical activities conducted by the Academy during its first decade (Section II). A compendium of these activities, including those that were joint efforts with the National Academy of Sciences and the National Research Council, together with membership rosters, appears in Appendices IV and V. Primary sources used in researching this material were the Annual Reports to the Congress and the Organization and Members books of the corporation.* The principal staff officers of those committees and boards which are still in

*National Academy of Sciences/National Academy of Engineering/ Institute of Medicine/National Research Council.

operation as units within the structure of the National Research Council were most helpful in reviewing the rosters of their units for accuracy.

Foremost, however, publication of this volume was made possible largely through the financial support provided by the Founding Members of the National Academy of Engineering, stimulated by the able leadership of the Founding President, Augustus B. Kinzel. This effort was viewed by the Founding Members as an opportunity to demonstrate again their faith and conviction in the principles and objectives of the National Academy of Engineering. The document stands as a tribute to their wisdom and foresight.



Courtland D. Perkins
President
National Academy of Engineering

FOREWORD

The National Academy of Engineering was formally established December 5, 1964. It was conceived of the idea that the benefits of technology to our society could and should be enhanced through prudent assessment and systematic application of our technical resources; and that the engineering profession could contribute much to this process. As the NAE approached its tenth anniversary, it appeared useful to review its early work, if indeed the past is prologue.

There were many stresses on our society during the NAE's first decade. A costly and bitter war tested national resources and sensibilities. Urban centers continued to spread outward, and the inner city continued to stagnate. Critics of technology asserted that social costs outweighed its benefits. And the energy crisis gave a painful reminder that the United States must learn to function in an interdependent and finite world, that even its rich resources have their limits.

These societal storms and changes have strengthened the tenets on which the Academy was founded -- that technology is pervasive; that it is essential to a modern society; but that it must be wisely applied for the greatest good.

The NAE is also firmer in its belief that technological planning goes beyond "hardware". Technical tools and methods must be applied in a framework that includes an understanding of societal institutions, the legitimate aspirations of different sectors, the financial resources available and anticipation of social costs that accompany even the most beneficial technological improvement.

Technology changes, and at times the only constant seems to be change. Within a few decades, nuclear power stations have increased the amounts of electricity fed into our power grid; television has come to dominate the information media; we've gone to the moon and are now exploring the planets; the computer has become a pervasive and essential element in our society.

However, change has also accentuated our failings. For example, there is still inadequate transportation and housing. Health care delivery is unbalanced, often acutely, in its effectiveness, quality, and availability. Minorities have yet to be given full opportunities by all sectors of society, the engineering profession included. We need judicious implementation of policies for wise use of our resources.

There is much to be done. As the Academy enters its second decade, it will continue its efforts in applying engineering skills to social problems. Its effort in the past ten years has largely been responsive -- that of fulfilling its function in examining questions of science and technology at the request of the federal government. We will continue in that role, in collaboration with the National Academy of Sciences and the National Research Council.

We will also seek, however, to enlarge our capability -- particularly by strengthening our financial resources -- to initiate studies we perceive are needed, as well as identify issues of potential future national concern and impact. We will, as was the case in the NAE's report on "U.S. Energy Prospects: An Engineering Viewpoint", confront critical issues in technology that are beyond the purview or mandates of individual governmental groups. And we will take care to see to our own house, as is the case in the NAE's continuing efforts to increase minority participation in engineering.

This volume is a brief introduction to the NAE's organization and work during its first ten years. Indeed, it would seem appropriate to view these years as introductory to the tasks that still lie ahead, and renew our commitment to service in the national good.

We hope you find this anniversary document both interesting and useful.

Robert C. Seamans, Jr.

Robert C. Seamans, Jr.
President
National Academy of Engineering

December, 1974
Washington, D.C.

THE NATIONAL ACADEMY OF ENGINEERING:

THE FIRST TEN YEARS

C O N T E N T S

Founding Members of the Academy. ii

Acknowledgements iii

Foreword v

I. THE ACADEMY'S DEVELOPMENT

Beginnings 1

Early Efforts and Development Planning 8

Relationship with the NAS and NRC 10

Membership. 18

Future Directions 19

II. THE ACADEMY'S WORK

Aeronautics and Space 21

Communications 24

Disasters 26

Education and Manpower. 29

Energy and Natural Resources. 30

Environment 33

Health. 38

Land and Housing 39

Marine. 43

Productivity. 46

Public Engineering Policy 47

Technology and International Relations. 49

Transportation. 51

APPENDICES

I. Membership of the National Academy of Engineering (as of May, 1974). 54

II. Officers and Councillors. 61

Officers 62

Council and Executive Committee. 64

III. Standing Administrative Committees. 68

Auditing Committee 69

Awards Committee 70

Biographical Memoirs Committee 71

Ad Hoc Development Committee 72

Finance Committee. 74

NAS/NAE Joint Board. 76

Committee on Membership. 77

Nominating Committee 81

Project Committee. 82

IV. Advisory Activities 84

Aeronautics and Space Engineering Board. 85

Bay Area Rapid Transit (BART) Impact Program Advisory Committee. 88

Ad Hoc Committee for the Bureau of Mines 89

Ad Hoc Committee on Conference on Summer Employment of Graduate and Undergraduate Engineering Students. 89

Ad Hoc Committee to Work with a Committee of the Engineering Foundation 90

Committee on Control of Wastes in Air, Water, and the Land 90

Commission on Education. 91

Board on Engineering Manpower and Education Policy. 93

Committee on Engineering Manpower Policy 93

Task Force on Energy 94

Task Force on Energy Program Planning. 94

Committee on Environmental Engineering 95

Ad Hoc Committee to Determine the Feasibility of Providing Advisory Services in the Field of Engineering in Medicine and Biology 96

Ad Hoc Fellowship Program Committee. 96

Committee on Industrialized Housing. 97

Integrated Utility Systems Board 97

Committee on International Activities. 98

Committee on the Interplay of Engineering with Biology and Medicine. 99

Marine Board 101

Committee on Mine Rescue and Survival Techniques. 103

Committee on Minorities in Engineering 104

National Advisory Council on Minorities in Engineering 105

Ad Hoc Study Panel of the National Science Foundation Experimental Research and Development Incentives Program. 106

National Science Foundation Liaison Committee 107

Ad Hoc Committee to Review the Need for Activities of the National Academy of Engineering in the Field of Engineering in Medicine and Biology 107

Task Force on the Patent System. 108

Committee on the Patent System 108

Committee on Power Plant Siting. 109

Advisory Committee on Project Gasoline 109

Committee on Public Engineering Policy 110

Space Applications Board 112

Committee on Technology Assessment 113

Ad Hoc Committee on Technology Transfer and Utilization 113

Committee on Telecommunications. 114

Committee on Transportation. 116

Voice of America Committee 118

V. Joint Activities. 119

Committee on Ambulance Design Criteria (NAS/NAE/NRC) 120

Committee for the Development of Criteria for Nonrail Transit Vehicles (NAE/NRC). 121

Advisory Committee to the Department of Housing and Urban Development (NAS/NAE) 122

U. S. National Committee on Engineering in Medicine and Biology (NAE/NRC) 123

Environmental Studies Board (NAS/NAE). 124

Committee on Medical and Biological Effects of Atmospheric Pollutants (NAE/NRC) 126

Committee on Mineral Science and Technology (NAS/NAE/NRC) 128

Panels for the Evaluation of National Bureau of Standards Programs and Activities (NAS/NAE/NRC) 129

Science and Engineering Committee Advisory to the National Oceanic and Atmospheric Administration (NOAA) (NAS/NAE/NRC) 130

Committee on Natural Disasters (NAS/NAE/NRC). 132

Committee on North American Datum (NAS/NAE/NRC). 133

Committees on Pollution Abatement and Control (NAS/NAE/NRC) 134

Committee on Radio Frequencies (NAS/NAE) 136

Committee on Rapid Excavation Techniques (NAS/NAE/NRC) 138

U. S. National Committee for Rock Mechanics (NAS/NAE) 139

Committee on Science, Engineering and Regional Development (NAS/NAE) 141

Committee on Scientific and Technical Communication (NAS/NAE) 142

Committee on the Scientific and Technologic Base of Puerto Rico's Economy (NAS/NAE/NRC). 143

Committee on Social and Behavioral Urban Research (NAS/NAE/NRC). 144

Committee on Urban Technology (NAS/NAE). 144

VI. Financial Aspects of Academy Operations. 145

VII. Publications of the NAE, 1964-1974 152

VIII. Symposia Held in Connection with Annual and Autumn Meetings of the NAE. 165

IX. Articles of Organization and Bylaws. 172

Articles of Organization. 173

Bylaws. 179

I. THE ACADEMY'S DEVELOPMENT

Beginnings

Origins

By the late 1950s, it was clear that American society was undergoing deep change. Suburbs were growing rapidly; the nature of mass and personal communication was changing; the computer was beginning to find its market. New technology was being introduced rapidly, its impact quickening and being widely felt.

During this time, leaders of the engineering profession in the United States became concerned about the limited involvement of engineers in matters related to national technological programs and policies. It was apparent, for example, that the engineering profession had no truly effective way to participate in the planning and use by society of technology, or to contribute to policy and program formulation. Engineering groups were largely discipline-oriented, confining their concerns to the interests of their members -- civil engineers, chemical engineers, etc.

What was needed was a mechanism for utilizing the combined strength of the profession and increasing its contributions to the public welfare. The idea gained momentum that one such mechanism would be to have a body of engineers of high caliber, which would be comparable to the National Academy of Sciences (NAS). As Augustus B. Kinzel, who became first president of the NAE put it: "The Academy [of Sciences] is like Caesar's wife. If the Academy takes a step it is not questioned as to competence, loyalty, integrity, and honesty. A similar situation does not exists in engineering circles, in spite of the fact that we are required to respond in like manner".[1]

---

[1]Minutes of the Organizing Meeting of the Engineers Joint Council National Academy of Engineering Committee, January 18, 1961.

The idea of a national academy of engineering was suggested in the late 1950s by Morrough P. O'Brien, Dean of Engineering at the University of California, to the Engineers Joint Council (EJC), the "society of societies" of major professional engineering groups. When the EJC presented the suggestion to individuals in government, however, it was rejected on the grounds that the formation of such an academy would drive a wedge between science and engineering to the detriment of both.[2] This concern apparently remained a consideration with Kinzel, for later on, as the concept of an engineering academy was brought to fruition, he continually advocated close cooperation between science and engineering.

In early 1960, J. Herbert Hollomon[3] again suggested, independently, that a national academy of engineering be established -- a recommendation which was reported in Science. After discussion with Hollomon, Harold K. Work, who was serving as Director of the Engineering Foundation in New York, presented the idea to the Foundation's Research Procedure Committee, of which Kinzel was Vice Chairman. Acting on the recommendation of that group, the Foundation's

---

[2]Harold K. Work, "The National Academy of Engineering, Its Purposes, Program and Probable Effect on the Future of the Engineering Profession", address presented at the meeting of the Providence Engineering Society, March 15, 1967. Enoch R. Needles, Chairman of the EJC, and Kinzel visited James R. Killian, Jr., Chairman of the Corporation, Massachusetts Institute of Technology and then Science Advisor to President Eisenhower, in the spring of 1960. Writes Kinzel: "We discussed the proposed Engineering Society with him. He agreed with our position and strongly advised that it be cooperative with the NAS, gave us much encouragement, and spoke to Stratton [Julius A. Stratton, NAS Vice President] about it." [Letter from Augustus B. Kinzel to Robert J. Burger, Executive Officer of the NAE, dated October 16, 1976.]

[3]Then General Manager of the General Engineering Laboratory, General Electric Company.

[4]The Engineering Foundation was established in 1914, as a department of the United Engineering Society "for the furtherance of research in science and engineering and for the advancement of the profession of engineering and the good of mankind". The Society, itself a creation of several major engineering societies, acted as custodian of the Foundation's endowment and turned income from the fund over to the Foundation for its use. [Engineering Foundation, "A Half Century of Service -- 1914-1964".]

Executive Committee -- chaired by Antoine M. Gaudin[5] -- in mid-June, 1960 authorized a feasibility study of a national academy of engineering. However, there was a strong feeling that the EJC should be involved, and discussion between the two organizations was initiated. The president of the Engineers Joint Council at the time was Kinzel.

First Study

In August, after a brief review, the EJC formed a committee to study the pros and cons of establishing an engineering academy, either as part of the National Academy of Sciences or as a separate institution. The EJC asked the Engineering Foundation for Work's services as Executive Secretary of the exploratory committee, and for $10,000 in supporting funds.

It was decided early on that any exploration with respect to a national engineering organization should include the National Academy of Sciences. It was believed that when the NAS was established by Congressional Charter in 1863, it was probably intended that engineering should play a larger role in the operation of the Academy than it actually had; it was pointed out that while the Academy of Sciences appeared to be oriented primarily toward science, extensive engineering activities were carried out by its working arm, the National Research Council (NRC).[6] And, there were ties of long standing between the engineering community and the NRC which, in its early years, received financial support and housing from the Engineering Foundation.

In any case, because the objectives of both the NAS and an engineering academy were considered to be similar, in a broad sense, it was stated that every effort should be made to see that there was close cooperation with the NAS so as to best serve the national welfare. Consequently, the Academy of Sciences was invited to participate in the discussions. Thus, the exploratory committee included representatives of the NAS and NRC as well as the EJC, the Engineering Foundation, and the Engineers Council for

---

[5]Then Robert H. Richards Professor of Mineral Engineering, Massachusetts Institute of Technology.

[6]Harold K. Work, "The Question of Establishing a National Academy of Engineering", presentation before the Engineers Joint Council, September 9, 1960.

Professional Development.[7] The study was underway within two months, the initial phase of a process that was to continue for four years, with the EJC taking lead responsibility and with financial and staff support from the Engineering Foundation.

Some of the points which were stressed during the course of the committee's discussions were that: it was necessary to make engineers more visible and vocal on the national scene; the pattern followed by the National Academy of Sciences could well be adopted for engineering; enlargement of the NAS to take care of engineering needs was impractical and would make the NAS unwieldy; whatever steps were taken vis-à-vis the engineering position should be done in collaboration with the NAS. The committee then went on record with the statement that "there is an unfulfilled need for a source of advice and guidance to the government on national affairs of engineering orientation"; and, upon endorsing a Kinzel proposal for an approach to the organizational need, voted in favor of the establishment of a national academy of engineering.[8] The specific recommendations, which were adopted with minor modifications by the EJC Board of Directors, were that:[9]

1. A National Academy of Engineering be established in cooperation with the National Academy of Sciences;

2. The initial membership and the constitution and bylaws be subject to approval by the Council of the National Academy of Sciences and the Board of the Engineers Joint Council;

3. A 12-man committee be formed to explore the founding of a National Academy of Engineering having the

---

[7]Labeled the "National Academy of Engineering Committee", the group had the following composition -- EJC: Walter R. Hibbard, Jr. (Chairman), Hendley Blackman, Enoch R. Needles, L. N. Rowley, Jr., Eric A. Walker, Jerry McAfee; Engineering Foundation: Andrew Fletcher, Antoine M. Gaudin; NAS: Detlev W. Bronk; NRC(NAS): Augustus B. Kinzel (elected to the NAS in 1960); ECPD: M. D. Hoover, William L. Everitt (ex officio).

[8]Minutes of the Engineers Joint Council National Academy of Engineering Committee, September 20, 1961.

[9]Minutes of the Board of Directors, Engineers Joint Council, November 17, 1961.

following composition: the president of the National Academy of Sciences, the vice president of the National Academy of Sciences, the chairman of the Engineering Section of the National Academy of Sciences, the chairman and the past chairman or chairman-elect of the Division of Engineering and Industrial Research of the National Research Council, seven members selected by the Engineers Joint Council with advice from the Engineering Foundation, one of whom shall be chairman.

Second Study

It was subsequently found that the NAS could not participate in the establishment of the 12-man committee with the EJC. However, Dr. Detlev W. Bronk, President of the NAS, appointed a special Academy committee to work with the EJC group.[10]

The EJC committee was charged with developing a proposal for the establishment of an engineering organization representative of the engineering profession which would be composed of engineers distinguished for major engineering achievements. The NAS committee was requested to consider how the proposed engineering unit could be integrated in the NAS in a manner satisfactory to the engineers and consistent with the principles of the Academy of Sciences.

On February 20, 1963 the EJC transmitted its proposal to the NAS committee, recommending that a national academy of engineering similar in character and complementary to the NAS, be established within the NAS framework through

---

[10]Engineers Joint Council Exploratory Committee on a National Academy of Engineering, proposal on "Establishment of a National Academy of Engineering", November, 1963, page 2; Minutes of the EJC Executive Committee, December 15, 1961 and March 21, 1962. When the appropriateness of the NAS establishing a formal joint committee was questioned, the EJC suggested the alternate approach of independent, collaborative committees. These had the following composition:

NAS	EJC
Julius A. Stratton (Chairman)	Eric A. Walker (Chairman)
Lloyd V. Berkner	Antoine M. Gaudin
Hugh L. Dryden	Walter R. Hibbard, Jr.
Augustus B. Kinzel	James N. Landis
George B. Kistiakowsky	Warren L. McCabe
	Enoch R. Needles
	Ernst Weber
	Harold K. Work (Executive Secretary)

appropriate modification of the NAS Charter, with the understanding that if it proved impossible to provide for an NAE charter within that of the NAS, the engineers might apply for their own with NAS support.

The result of the negotiations between the two committees was that the NAS agreed to collaborate with the EJC committee looking toward the establishment of a National Academy of Engineering affiliated with the National Academy of Sciences. Such collaboration was to be through a committee appointed by the NAS president, and all decisions regarding the proposed academy were to be ratified by the NAS Council. After a five-year trial period, the respective academies were to review their relationship and decide upon whether the affiliation should be made permanent. The NAS membership approved this agreement at their Annual Meeting that year.

Establishment

The final steps to establish the National Academy of Engineering were initiated in the fall of 1963 when the NAS appointed a new collaborating committee composed of Julius A. Stratton (Chairman, Vice President of the NAS), Lloyd V. Berkner, Augustus B. Kinzel, George B. Kistiakowsky, Frederick Seitz, Thomas K. Sherwood, and C. Richard Soderberg. In the meantime, the EJC Committee chaired by Eric A. Walker -- President of the Pennsylvania State University, and also by then EJC President -- has proceeded to draft proposed articles of incorporation and bylaws. The following March, upon the recommendation of the EJC, NAS President Frederick Seitz appointed a formal incorporating "Committee of Twenty-Five" (10 from the Engineering Division of the Academy of Sciences and 15 non-members -- all prominent engineers) charged with working as the National Academy of Engineering Committee of the NAS to secure a federal charter for a National Academy of Engineering and take the necessary steps to establish it.

It was to this group that Seitz, in the interest of saving about two years' time and ensuring close cooperation between science and engineering, subsequently suggested an alternate founding mechanism; namely, a clause in its 1863 Congressional Act of Incorporation giving the NAS the right to "make its own organization, including constitution, bylaws, rules and regulations". The "Seitz Plan" called for the establishment of the engineering academy under the Charter and within the framework of the NAS. This schema would permit the NAE to select its own members, officers, and governing council; establish its own bylaws; and entitled the NAE to use the existing NAS facilities and issue reports in its own name.

Subsequently, the NAS membership voted to "encourage the NAS president and Council to proceed with plans for the establishment of a National Academy of Engineering under the Charter of the NAS".[11] On December 5, 1964, the Council of the NAS approved the Articles of Organization of the National Academy of Engineering, thus bringing the NAE into being. Five days later, the Committee of Twenty-Five, acting as Founding Members,[12] adopted bylaws.

The objects and purposes of the new Academy were declared:

- To provide means of assessing the constantly changing needs of the nation and the technical resources that can and should be applied to them; to sponsor programs aimed at meeting these needs; and to encourage such engineering research as may be advisable in the national interest.

- To explore means for promoting cooperation in engineering in the United States and abroad, with a view to securing concentration on problems significant to society and encouraging research aimed at meeting them.

- To advise the Congress and the executive branch of the government, whenever called upon by any department or agency thereof, on matters of national import pertinent to engineering.

- To cooperate with the National Academy of Sciences on matters involving both science and engineering.

- To serve the nation in other respects in connection with significant problems in engineering and technology.

- To recognize in an appropriate manner outstanding contributions to the nation by leading engineers.

---

[11]Minutes of the Business Session, NAS Autumn Meeting, October 12, 1964.

[12]Founding Members were: H. W. Bode, W. L. Cisler, H. L. Dryden, E. W. Engstrom, W. L. Everitt, A. M. Gaudin, M. L. Haider, G. E. Holbrook, J. H. Hollomon, T. C. Kavanagh, A. B. Kinzel, J. N. Landis, C. H. Linder, C. B. Millikan, N. M. Newmark, W. H. Pickering, S. Ramo, A. E. Raymond, T. K. Sherwood, J. A. Stratton, C. G. Suits, F. E. Terman, C. A. Thomas, E. A. Walker, and E. Weber. (See page ii.)

Early Efforts and Development Planning

Appropriately, Augustus Kinzel was elected the NAE's first president by the Founding Members and Dr. Work was asked to become the Academy's first secretary. Kinzel was succeeded in 1966 by Eric Walker, and in 1970 Clarence H. Linder, Vice President of General Electric, was elected the Academy's first full-time president. Robert C. Seamans, Jr., formerly Secretary of the Air Force, assumed the presidency in 1973.[13]

From the beginning, the NAE functioned as an independent organization within the NAS structure. Autonomous in such matters as internal organization and election of members, in its advisory functions it operated in close coordination with the NAS and shared in the responsibility of providing the various federal agencies with the information and advice they needed in matters of scientific and technical concern. Through this arrangement, the National Research Council was available to serve both academies in the discharge of their responsibilities.

The NAE organizational structure was modeled somewhat on that of the NAS: a Council with an Executive Committee, that established and oversaw the function of advisory committees which performed technical studies. The administration and other staff functions, including coordination of joint studies with the NAS and/or NRC, were also under the aegis of the Council, as were standing committees for such internal operations as awards, auditing, finance, membership, and nominating.

Within a year of its founding, the NAE moved its offices from the Engineering Foundation in New York City to the NAS building on Constitution Avenue in Washington, D.C. The fledgling Academy was soon involved -- deluged may be more appropriate since there was then a total staff of five -- in several projects, including joint

---

[13]Dr. Seamans resigned as president on December 29, 1974 to become the first administrator of the Energy Research and Development Administration (ERDA). Courtland D. Perkins, the NAE's fifth and current president, assumed the position April 24, 1975. William E. Shoupp, NAE Vice President, served as acting president in the interim.

efforts with the NAS and the NRC, such as:

- An advisory study relating to utilization of ocean resources;
- A study on the state-of-the-art of earthquake engineering, with recommendations for a research program and follow-up damage reports on an actual earthquake;
- A study on the scientific and technological base of Puerto Rico designed to assist in its industrial and economic development;
- A symposium on traffic safety to examine the causes and consequences of traffic accidents.

Responsiveness to the needs of the federal government was and is a primary Academy objective; another is to initiate studies when it sees the need. However, while the ambitions of the new NAE were large, its immediate resources were limited. As a start there were three Engineering Foundation grants totalling $30,000. In July, 1965, largely through the efforts of President Kinzel, a $500,000 grant came from the Alfred P. Sloan Foundation -- $400,000 to be applied toward the cost of the new NAS auditorium then under construction, the balance identified as unrestricted funds in support of initial operations. A particular area of concern was, though, and continues to be, an insufficiency of unrestricted funds to support new initiatives, especially in enabling the Academy to work in areas not mandated by a federal department. The NAE's first effort to raise such income was highly successful, thanks to the endeavors in 1967 of a group of Academy members headed by Philip Sporn, Chairman, System Development Committee, American Electric Power Company.

This led to a surge of new activities by the NAE, notably in the areas of energy and environmental engineering. In 1969, the Academy organized a development planning effort around a series of workshops for members, to search out and define critical areas. Three were identified, leading to the creation of new NAE committees on Engineering Aspects of Environmental Quality (CEAEQ, later Committee on Environmental Engineering), on International Activities, and on Transportation. One of the activities initiated by the CEAEQ was the well received energy-related study on power plant siting described on page 31.

The Office of the NAE Foreign Secretary was created at this time also, to work closely with the existing Office of the NAS Foreign Secretary. Bruce S. Old, Senior Vice President of Arthur D. Little, Inc., was appointed to the position in January, 1970, and held the post for five years. The NAE foreign secretary was responsible directly to the NAE Council for the Academy's international activities, and simultaneously served as chairman of the newly created Committee on International Activities which was to be responsible for Academy participation in this sphere. To facilitate cooperation with the NAS in this area, Old was also appointed a deputy foreign secretary for engineering affairs of the National Academy of Sciences.

Thus the NAE expanded its scope, both in terms of technical and advisory activities and internal operations. By the end of 1970, the committee structure and work had more than doubled, and joint activities tripled. The membership reached 329 and the original staff of five had expanded to almost 50. A wide spectrum of engineering disciplines was brought into play in a series of activities ranging from aerospace engineering to transportation and engineering policy.[14]

Relationship with the NAS and NRC

The National Research Council was established by the NAS in 1916 at the request of President Wilson. It was conceived as the working arm of the NAS, consisting of a volunteer pool of talent with wide ranging expertise in the many issues considered by the Academy. It has evolved through the years to become the institutional framework for most of the studies conducted under the aegis of the NAS and the NAE.

Following its establishment in 1964 and especially by the late 1960s the NAE's role with respect to the National Research Council had become a troublesome issue for both NAS and NAE, centering on the point that the best means to accomplish a scientific study is not always the best way to carry out an engineering study.[15]

---

[14]Representative technical activities of the Academy during its first decade are described in Section II, "The Academy's Work".

[15]Eric A. Walker, "Report of the President" to the members of the National Academy of Engineering, April 30, 1970.

The NRC was controlled via its Governing Board by the NAS Council. The NAE felt it should have a more direct voice in NRC operations, particularly those pertaining to engineering and technological matters. This harked back to the rationale which sparked the creation of the NAE, namely, service to the nation by making the highest resources of the profession available for the attack upon the technological problems confronting modern society -- a principle similar to that upon which the NAS was founded. Moreover, this was to be done through the membership, for the NAE was intended to be a working organization, with as many members as possible participating in its operations.[16]

It was assumed by all that the NRC would be fully utilized by the NAE in the same manner that the NAS had used the NRC. In particular it was expected that the NAE would jointly manage with the NAS those activities of the NRC relating to engineering -- an estimated 40 percent of the Research Council's programs.[17] However, effective joint management of these activities did not materialize.

Thus, as the NAE approached its second anniversary, although President Walker was able to write that "things have worked out very well",[18] some elements of competition were incipient.

---

[16]Julius A. Stratton, "Advice to a New Academy", Science, Vol. 149, September 10, 1965, pp. 1206-1208. Minutes of the NAE Council, June 17, 1968, Appendix I, presentation by Eric A. Walker.

[17]In a presentation on April 27, 1964 at the first meeting of the Committee of Twenty-Five, President Seitz said, "Speaking in general terms, I am inclined to think that it (a close association of the NAS and NAE) would imply working toward joint management of the aspects of the NRC which are closely related to engineering". Again, reviewing NAS/NAE operations in mid-1966, Seitz wrote: "It is intended that the NAS and NAE use the NRC jointly to serve most of the advisory responsibilities of the NAS corporation regardless of which Academy may have the primary interest....As the NAE receives requests to carry through advisory work, it is anticipated that it will almost without exception wish to use the NRC as the organization for managing advisory studies..." [Frederick Seitz, letter to NAE members dated June 27, 1966, transmitted with cover letter signed by Eric A. Walker, dated June 28, 1966.]

[18]Walker, ibid.

The NAE's only formal input into the NRC was through the representation of the Executive Committee of the NAE Council on the Governing Board, otherwise composed of members of the NAS Council, the chairmen of the divisions of the NRC, and the chairman of the Advisory Committee of the Office of Scientific Personnel of the NRC. However, only members of the NAS Council on the Governing Board were permitted to vote on fiscal matters. The NAE, Seitz wrote, shares joint responsibility and authority in the operation of the NRC, and its Council is parallel to that of the NAS except that the latter has special responsibilities toward the NAS corporation. He pointed out the dual nature of the NAS -- as an honorific membership society and as an umbrella organization over the NAE, NRC, and NAS proper, in which role "it is the legally and fiscally responsible corporate body within which the NAE and our other component parts play a role. It is my opinion that as the pattern of organization we jointly have initiated in creating the NAE as part of the NAS corporation develops, the NAE will gradually grow closer to the NAS in sharing responsibility for the operation of the NAS corporation".[19]

Finding meaningful discussion of policy in the Governing Board difficult, the NAE came to view the staff and committees as the level at which serious direction could be given to the work of an NRC activity. Here too, it appeared that no satisfactory mechanism was established although there were efforts to develop more direct NAE contact with the NRC.[20]

The key to the increasingly complex interrelationships between the NAS, the NAE, and the NRC was the divergent philosophic approaches of the two Academies to the NRC. Simply stated, the NAS assumed it had open-ended responsibility to provide technical study services to all govern-

---

[19]Seitz, ibid.

[20]For example, the NAS Council invited the NAE Council to designate an NAE member to serve as vice chairman of the NRC, and Clifford C. Furnas was so appointed in late 1967. He had limited authority, however, for as Seitz observed, "...the NRC has only one officer, i.e., a chairman, who is also President of the National Academy of Sciences..." and the NAS executive officer serves the NRC in the same capacity and has principal staff responsibility for its programs. [Seitz, ibid. See also Minutes of the NAS Council, April 24, 1966; Minutes of the NAE Council, November 16, 1967, January 18, 1968, and June 17, 1968.]

ment agencies, with the resultant growth of its administrative arm, the NRC, as a large organization for the management of these studies in various fields, involving more non-members than members. Consequently, some in the NAE viewed the contribution of the NAS membership to the NRC and the operative interaction between the NAS and NRC to be minimal and its management to be somewhat diffuse.[21]

On the other hand, on the basis of its founding principles as a working organization whose expertise and knowledge would be made available to government, the NAE emphasized the effectiveness of membership participation and strong central management. Although not precluding the use of non-NAE people, this criterion presented a practical limitation to growth.[22]

Consequently, the NAE decided to try operating in two different ways. Seeking to maintain closer liaison with its technical committees, the Academy established several units directly responsible to its Council.[23] At the same time it continued to use the mechanism of joint committees with the NAS and within the NRC, primarily in the Division of Engineering.[24] Despite this, there were, apparently, mixed feelings among the members about the NAE developing its own committee structure.[25]

---

[21]Letter from NAE Councillor Chauncey Starr to Eric A. Walker, dated May 9, 1968; "Science's All-Purpose Savant", Business Week, March 30, 1967, pp. 157-158; Minutes of the NAE Council, June 17, 1968, Appendix II, presentation by Frederick Seitz.

[22]Ibid.

[23]For example the Aeronautics and Space Engineering Board, the Committee on the Interplay of Engineering with Biology and Medicine, the Committee on Mine Rescue and Survival Techniques, and the Committee on Telecommunications.

[24]Many of the organizational problems revolved around NAE's relationship with the NRC's Division of Engineering. The first major NAE technical committee, for instance, the Committee on Ocean Engineering, initially placed in the Division, was withdrawn and reconstituted at the request of its members under the aegis of the NAE Council because it was felt the NAE had lost administrative control of it. [Minutes of the NAE Council, June 17, 1968, Appendix I; and December 9, 1968.]

[25]Ibid. Also, correspondence between members of the Council, summer, 1968.

As Detlev Bronk put it,[26] "one of the difficulties that we kept coming up against was in clarifying the difference between an engineer and a scientist..."; yet it is important to have an intimate relationship between the two Academies and joint responsibility for the NRC. As the time gap between fundamental research and its engineering application closes, the need for cooperation grows.

Recognizing the need to clarify the intertwining relationships, the Academies agreed to joint meetings of their representatives during the summer of 1968 to discuss NAE operations.[27] On November 4 that year, the Joint NAS/NAE Study Group agreed that a plan for reconstituting the NRC Governing Board should be drafted for consideration by the Councils of the two Academies.[28] This plan called for maintaining the present organizational structure of the NRC but proposed reconstitution of the Governing Board to include the Executive Committees of the two Councils, the chairmen of the eight NRC divisions and the chairman of the Advisory Committee to the Office of Scientific Personnel.

---

[26]Minutes of the NAE Council, June 17, 1968, Appendix III, presentation by Detlev W. Bronk, NAS past-President.

[27]Namely, the manner in which the NAE could operate to preserve the essential identity that its membership found necessary, and the manner in which it could work effectively within the overall corporate NAS structure. [Minutes of the NAE Council, April 24, 1967; Minutes of the Joint NAS/NAE Study Group, August 5, 1968.] Seitz and Walker apparently felt that the NAS/NAE Joint Board set up in compliance with the Articles of Organization to consider policy matters was too small and limited for the task. [Minutes of the NAE Council, June 17, 1968, Appendix I.] The Joint Study Group, precursor of the Joint Negotiating Team created some three years later, consisted of the Executive Committee of the NAE Council and an NAS *ad hoc* Group as follows:

NAE	NAS
Henri G. Busignies	Detlev W. Bronk
Walker L. Cisler	Harvey Brooks
Walter R. Hibbard, Jr.	Nathan M. Newmark
Clarence H. Linder	Emanuel R. Piore
John R. Pierce	Frederick Seitz (NAS President, *ex officio* member of the NAE Council and its Executive Committee)
Eric A. Walker	Julius A. Stratton
	John C. Warner

[28]Minutes of the Joint NAS/NAE Study Group, November 4, 1968.

The document noted that the NAE Council would continue to assign certain operations to its own boards and committees reporting directly to it. One basis for assigning a project to an NAE rather than an NRC group would be the conclusion that the work should be performed primarily by NAE members.

When the NAE was formed, provision had been made to review its organizational status within the NAS corporation at the end of five years. In December, 1969 a committee consisting of NAE members H. Guyford Stever (serving as Chairman), Julius A. Stratton, and Edward E. David, Jr.[29] was appointed to conduct such a review of NAE operations and report back to the NAE Council. Meanwhile, Frederick Seitz was succeeded in the NAS presidency by Philip Handler, who, responding to the growing feeling within the NAS that the NRC should be reorganized, appointed a committee chaired by Franklin A. Long, Vice President for Research and Advanced Studies, Cornell University, to make a study of the NRC and its relationship with the NAS and NAE.[30] The Long Committee Report, made to the NAS Council in March, 1970, in part suggested that the NRC be reorganized and that its discipline-oriented divisions be replaced by problem-oriented councils -- for example, on transportation, environment, etc. -- and recommended the creation of institutes which would provide a "linkage between the NAS and the councils of the NRC".[31] Additionally, it was proposed that the NAS consist of four distinct academies (Mathematical and Physical Sciences, Life and Social Sciences, Health Sciences, and Engineering).[32] While at its Business Session on April 28, 1970, the membership of the NAS did not take action on specific recommendations, it accepted the report on the reorganization of the NRC

---

[29]Respectively, President, Carnegie-Mellon University; Chairman of the Board, The Ford Foundation; Executive Director, Research Communications Systems Division, Bell Telephone Laboratories, Inc. [Minutes of the NAE Council, November 7, 1969.]

[30]Lawrence R. Hafstad, Vice President, Research Laboratories, General Motors Corporation, was appointed to the Long Committee as an NAE representative. Ibid.

[31]"The Organization and Functions of the National Academy of Sciences and National Research Council", Report of the Committee on the Review of the National Research Council, March 10, 1970.

[32]Ibid.

and instructed President Handler to proceed with further discussions on the proposed restructuring and to develop alternative proposals to include a more precise statement of objectives, relationships, and responsibilities.[33]

NAE's reaction to the Long Report and its qualified endorsement by the NAS membership was cautiously positive, although several questions were raised as to whether the proposed reorganization plan could fulfill the objectives of the NAE.[34] The NAE Council later accepted the Stever Committee recommendations to work with the NAS in exploring the potential of the Long Report and in seeking a clear definition of the organizational questions and differences as well as active participation by the NAE Council in any proposed reorganization of the NRC.[35] The Council authorized Clarence H. Linder, elected April, 1970 to succeed Walker as NAE president, to proceed with developing recommendations on alternative organizational structures for the NAE.[36]

Discussion between the NAS and NAE on the reorganization of the NRC and the concomitant NAS/NAE/NRC relationships continued for three and a half years, often becoming tortuous and strained. Negotiations were conducted by representatives of the Academies, eventually constituting a Joint Negotiating Team, reporting directly to their respective Councils.[37] Meanwhile, the NAS proceeded to

---

[33]Annual Report to the Congress for the NAS corporation for the fiscal year 1969-1970, summary of the Business Session of the 107th Annual Meeting of the NAS, p. 144.

[34]Specifically, the questions related to the management responsibilities, financial independence of the Academies, and study committee structure. [Minutes of the NAE Council, March 11, 1970 and May 1, 1970.]

[35]Minutes of the NAE Council, April 3, 1970 and May 1, 1970.

[36]Minutes of the NAE Council, May 1, 1970.

[37]The Stever Committee was eventually succeeded by an *ad hoc* committee concerned with reorganization of the NRC consisting of the NAS and NAE presidents and two representatives from each Council -- James V. Neel and John W. Tukey for the NAS; and Robert W. Cairns and John H. Dessauer for the NAE. [Minutes of the NAE Council, April 30, 1971, June 15, 1971, and December 20, 1971.] The individuals serving as the Joint Negotiating Team in late 1973 when negotiations finally came to fruition were: Robert W. Cairns, John H. Dessauer, and Frederick A.L. Holloway (NAE); Emanuel R. Piore, Kenneth S. Pitzer, and Harrison Shull (NAS).

implement some aspects of the Long Report and the NAE explored three options for its future operations: continuing the status quo; separate incorporation of the Academy as a not-for-profit corporation; accomodation with the NAS on joint governance of the NRC.[38]

The reorganization issue was finally resolved in the fall of 1973 when the Councils of the NAS and NAE individually approved a "Statement of Principles Governing Joint Operation of the NRC by the NAS and NAE".[39] This agreement, overwhelmingly endorsed by the memberships of the Academies at their Annual Meetings the following year, was promulgated July 1, 1974. Thereby, all advisory activities of the Academies were to be undertaken within the NRC, reorganized into eight major units, including the Assembly of Engineering incorporating all existing NAE studies.[40] The Governing Board was reconstituted to include seven representatives from the NAS Council, four from the NAE Council, and two from the Council of the Institute of Medicine (IoM) of the NAS. The president/NAS would serve as chairman/NRC and the president/NAE as vice chairman. Additionally, the chairman of the Assembly of Engineering was to be nominated by the Council of the NAE.[41] In this way, the interest and responsibility which the NAE shares with the NAS in a variety of inter-disciplinary programs was recognized.

---

[38]Minutes of the NAE Council, April 30, 1971.

[39]By the NAS Council on October 21, 1973 and by the Executive Committee of the NAE Council, acting for the Council, on October 24, 1973. Robert C. Seamans, Jr. had been elected to the NAE presidency by this time, succeeding Clarence Linder, who had resigned in May of that year.

[40]Responsibility for many aspects of the operations of the total NRC were accordingly delegated by the Governing Board to these units: four discipline-oriented Assemblies on Behavioral and Social Sciences, Engineering, Life Sciences, Mathematical and Physical Sciences; and four multi-disciplinary Commissions on Human Resources, International Relations, Natural Resources, Sociotechnical Systems (into which were placed the old Division of Engineering projects).

[41]NAE President Courtland D. Perkins currently serves also in this capacity.

Membership

Election to membership and foreign associateship in the NAE is on the basis of identifiable contributions or accomplishments in one or both of these categories: (1) important contributions to engineering theory or practice, including significant contributions to the literature of engineering, and (2) demonstrations of unusual accomplishments in the pioneering of new and developing fields of technology.[42]

In theory, the nomination and election process of the NAE is a straight-forward matter but, in practice, sometimes difficult to implement. Credit for accomplishments in scientific research, for instance, can be traced through publications, while the source of significant engineering accomplishments is often hidden in blueprints, design products, computer programs, and finished structures.

To deal with such considerations, the NAE has evolved a fairly sophisticated election process which, by the Twelfth Election concluded in spring, 1974, involved the efforts of over 75 volunteers and three full-time staff. This election brought the NAE membership to 503 (see Appendix I); up to that time, however, the provision for electing foreign associates had not been activated.

Nomination and election procedures are developed by the Committee on Membership and approved by the Council of the Academy, and ultimately involve the entire membership. The multi-step process has always required that each candidate be nominated by an Academy member and that each nomination be supported by a specific number of references who are also Academy members. The mechanism for the evaluation of nominations has undergone several refinements during the Academy's first decade, but always with the intent of enhancing the effectiveness of the election cycle in ensuring the eminent qualifications of candidates.

The search for qualified candidates and growth of the membership offer the NAE an opportunity for continuing self-examination. The high quality of that membership, with its diversity of expertise, is the strength of the Academy and its base for continuing to meet its purpose of infusing engineering viewpoints into consideration of national issues.

---

[42] Articles of Organization, Article V; Bylaws, Article II, Section 4.

Future Directions

The NAE made significant contributions to the solution of national problems in its first ten years, largely from organizing and applying its expertise to problems that were of concern to specific federal executive departments. It now has the opportunity to perform an expanded national service by acting in concert with the NAS and IoM, using the NRC as the institution for this collaborative effort. In this way the opportunities for the NAE have been broadened so that more effective ongoing support can be provided the federal government.

Many of our most vexing national problems, however, are of a kind and a scale that transcend narrow institutional boundaries. The complex interdependence of our society is increasingly evident through the emergence of problems that affect large numbers of persons, yet are not within the jurisdiction of any specific institutional entity -- a situation in which everybody's problems are nobody's responsibilities. Many of the most pressing problems have their solutions, if they exist, in scientific discovery and technological development -- energy, food, pollution, water resources, materials resources, and transportation represent few.

Anticipatory initiatives by the NAE to provide the needed national focus on these classes of problems could expedite the development of long-term policies and programs for their implementation. Properly conducted, such leadership efforts would enhance the capability of NAE members as individuals, and the Academy as an institution, to participate more effectively in the formulation of vital national actions.

The NAE is investigating appropriate areas of study in which it could take the initiative, together with approaches, modes of operation, and methods of financing. From this review there will emerge a blueprint for future initiatives that could be undertaken by the Assembly of Engineering, other NRC units, or by the NAE itself, if appropriate. Such initiatives, coupled with a continuing broad program of support for current governmental activities, promise an even more expanded NAE involvement in vital national problems than it has had in its first decade of existence.

II. THE ACADEMY'S WORK

Technology enables man to exert his will over his surroundings, and in the 20th Century that ability has increased vastly. That a strong technology is essential to a modern society seems axiomatic. Technology can increase productivity to yield more goods at lower cost. Optimization and other technological tools can assist in making the most effective use of finite resources. Technology can contribute to the maintenance of a favorable balance of trade. Imaginative uses of communications' technology can help in redressing education imbalances for disadvantaged inner city children. Earth surveys by satellite can report on the state of our planet, assist in locating resources, and assess the effects of man's activities.

However, if improperly used, technological benefits may be achieved at the expense of inordinate social costs. Avoiding such imbalances requires reasoned judgments of the costs, benefits, and effects of technological options. Quoting Jerome B. Wiesner, "many of the problems the world faces will require substantial doses of technology if they are to be solved -- sensitively relevant technology, conceived and developed with the understanding that technology can create problems, too".[43]

The National Academy of Engineering has attempted to focus its activities on specific issues of relevant technology, with efforts encompassing not only technological expertise, but also balance of technology with societal and economic factors. This is the thrust of engineering.

---

[43]Jerome B. Wiesner, (President, Massachusetts Institute of Technology), "Technology is for Mankind", Technology Review, May, 1973, page 10.

Representative examples of some of the NAE's work during its first decade are described in the following pages. Those advisory units which were transferred to the Assembly of Engineering of the National Research Council when the Assembly was established July 1, 1974, are included in Appendix IV.

Aeronautics and Space

The Academy's role in the nation's aeronautics and space effort has been to seek a basis for recommending research and development priorities for programs to be supported by the government, to assure the continued strength and pertinence of the nation's research programs, and to assist in the sound management of our national development efforts.

Two boards of the National Academy of Engineering shared the responsibility of working with the National Aeronautics and Space Administration (NASA) in reviewing the nation's aeronautics and space programs. The Space Applications Board (SAB) formed in 1973, concentrated on identifying major services which could be provided more usefully or economically by space-based systems. The Aeronautics and Space Engineering Board (ASEB), established in 1967, concentrated in more detail on the technological content of ongoing and planned programs within NASA and other government agencies (Departments of Defense, Transportation, etc.). The ASEB has served also as a source of information and has provided engineering assistance to the Space Science Board of the National Academy of Sciences during its deliberations concerning the use of space for scientific purposes.

While civil aviation is only a part of the total transportation system, it has been by far the most dynamic. Flight vehicle design for civil air transportation is influenced not only by advancements made possible by expanding aeronautical technologies, but also by the extent to which air transport systems are compatible with the total transportation system and the population it serves. Aviation research and development in the past has been concerned primarily with improving flight vehicle performance. It remains essential that the total system of air space use, social impact, and energy utilization be considered so that new research can be directed toward the most critical problems of the total system.

As the result of consultation with officials of NASA, the Department of Transportation (DoT), the Federal Aviation Administration (FAA), the President's Science Advisor, the National Aeronautics and Space Council, as well as other government and private groups, the Academy's ASEB conducted "An Assessment of Federal Government Involvement in Civil Aviation Research and Development". After considering the multiplicity of factors affecting the growth of civil aviation, it was concluded by the study that the three most critical factors are: (1) airport and support facilities, (2) noise, and (3) air traffic control. The most important recommendation concerned the necessity of knitting together more tightly the civil aviation research and development activities of the DoT with its major operating unit, the Federal Aviation Administration, and NASA -- and especially the desirability of dividing their responsibilities according to capability.

The Academy effort provided the framework for the subsequent Civil Aviation Research and Development Policy Study (CARD), which was undertaken jointly by the Department of Transportation and NASA in response to a recommendation by the Senate Committee on Aeronautical and Space Sciences of the 90th Congress. This study concurred with the earlier ASEB assessment that noise and congestion, the latter encompassing air traffic control and airport facilities, are the two highest priority problems facing civil aviation.

In considering the results of its ongoing studies, the ASEB suggested the following major areas of emphasis appropriate of recognition by NASA in creating future aeronautical technology programs:

- the need to continue a strong, technically-oriented program to insure that later generations of commercial aircraft will be inherently more socially acceptable, economically viable, and efficient in the use of limited energy resources;

- the need for continuous consideration of air transportation as an essential mode in our national and international transportation network;

- the necessity of addressing not only the airplane and propulsion elements in maximizing the potential operational efficiency, but also the total operating system to determine if new concepts of system elements can help in minimizing energy consumption or in reducing unwanted social impacts.

Among the many activities undertaken by the ASEB, two relate closely to the first and second foregoing major areas of emphasis. One dealt with considerations of the technology critical to possible eventual development of an advanced supersonic transport-type aircraft. On this matter the ASEB believed attainment of an economically and ecologically viable supersonic transport to be still elusive, requiring a significant breakthrough in some combination of propulsion, structure, and aerodynamics. It was suggested that NASA attempt to emphasize fundamental research that holds promise of significant gains in drag, structural weight, and propulsive efficiency.

The second activitity dealt with conservation of aircraft energy and methods by which it might be improved. Certain of the ASEB's early deliberations have been adopted by NASA in accelerating its program on alternative aircraft fuels, a program that has included also the U.S. Armed Forces and segments of the aerospace industry. Other ASEB suggestions dealt with the distinct possibility, by the 1980s, of a subsonic, commercial jet transport airplane designed for operation within a sophisticated air traffic control system with up to 50% savings in fuel: a prerequisite is timely availability of adequate funds to permit essential technological advances.

In recognition of the need for suppression of helicopter and V/STOL noise in military operations, the United States Army Research Office sponsored a joint Army/NAS/NAE conference on the matter. The conference concluded that noise of V/STOL configurations can be appreciably reduced but, unfortunately, only by penalizing performance severely. Two recommendations emerged in the ASEB's report of the conference: (1)that criteria should be established for determining the quantitative benefits and costs of noise reduction in both military and commercial operations; and (2)that a basic research program including analytical studies and experimental investigations should be initiated to determine the mechanisms of noise generation by rotors and propellers.

In the course of meeting the national goal of landing men on the moon and safely returning them to earth, technological capabilities have been developed which have important potential uses for the benefit of mankind. A main thrust of the nation's space program could now be directed at assuring the application of these capabilities to surveys of the resources of the earth (particularly food and energy resources), exploration of new services which communication satellites may provide, and other endeavors related to man's activities on the earth. Since 1972 the Academy, through its Space Applications Board, has provided to leaders in the federal government an independent assessment of issues and activities related to such practical uses of space systems.

One of the problems identified by the board is the lack of adequate institutional means to link effectively those who are potential users of the information and services which earth-oriented satellites can provide with the technologists who develop and operate space systems, so that space systems and space technology may be fully responsive to user needs. Accordingly, the board conducted, during the summer of 1974, a user-oriented study of practical applications of space systems. This study brought together about 100 persons from federal, state and local governments, business and industry, and the academic community, about 70 of whom were senior and experienced resource managers and other potential users. The study considered the possible applications of space systems to monitoring and predicting weather and climate, to communications, to land use planning, to agriculture, to detection and monitoring of the quality of the environment, to marine and maritime activities, and to processing of materials in space. The results of the study, in terms of what information is needed by users, how they use the information in making decisions, and what impact space-derived data might have on results achieved and on costs of obtaining the needed information, are expected to have an important influence on space program planning.

Communications

Communications is the transmittal of information between people, between people and machines, and between machines. In a modern society communications is a major concern in numerous vital areas: urban services, health-care delivery, crime control, transportation, and education, for example. The bulk of the Academy's work in communications has been in tele-communications -- the acquisition, transmittal, and processing of information electronically.

The NAE's Committee on Telecommunications was initially organized in 1968 at the request of the President's Task Force on Communications Policy, to provide counsel on telecommunications technology for a study being conducted by the Task Force. The committee set up three panels dealing with: (1) long distance communications by wire, radio, and satellite; (2) electromagnetic compatibility (spectrum utilization); and (3) urban communications. The final report on this assignment was completed in November, 1968, with a major part of the work involving informal contacts between the panels and the Task Force. The work of the Urban Panel as a practical study of technology applied to societal needs, showing the manner in which electronics-information technologies could be used more imaginatively to upgrade city functions, was of such interest that the Department of Housing and Urban Development (HUD), which had provided the funding for the original study, organ-

ized a federal consortium to fund a deeper study on how telecommunications could contribute to better life in the cities. The consortium included the Departments of Commerce and Transportation, the National Science Foundation (NSF), U.S. Postal Service, and the Federal Communications Commission. Later, the Department of Health, Education and Welfare (HEW) signified its intention to join.

As the result of a study commissioned to make specific suggestions for telecommunications pilot projects to improve city life, the committee developed 18 specific recommendations, a number of which are being implemented in various stages of experimental study and applications. Among these are: several telemedicine projects sponsored by HEW and NSF for the application of communications-information technologies to improve health care; an in-depth examination by the Department of Justice of the Automatic Location Identification of an emergency phone call conducted in Alameda County, California; the New Rural Society Project in Connecticut, funded by HUD, to examine the use of telecommunications as a tool for stimulating desirable regional development; two major developmental projects in computer-assisted instruction -- PLATO[44] at the University of Illinois and TICCIT[45] at the Mitre Corporation -- funded by the NSF.

At the request of the NSF the committee examined the subject of telecommunications research in the United States and other technologically advanced countries. The study concluded that this country is doing well in most important areas of telecommunications research, but that significant improvement is needed in the application of the results of this research to societal betterment and to products and services useful toward a better U.S. balance of international trade. As the result of the committee's conclusion on international trade, an important study on the subject was initiated by the Department of Commerce.

The committee's panel on Electromagnetic Compatibility, whose name was later changed to the Panel on Spectrum Value, looked into the complex subject of how social and economic values could be applied to spectrum management. The panel concluded that no useful mathematical formula could be designed for making spectrum value judgments, and that the optimum practical management of the spectrum depended on wisely weighing the pros and cons of various options, and taking appropriate action on the basis of all the relevant information.

---

[44]Programmed Logic for Automatic Teaching Operation.

[45]Time-shared, Interactive Computer-Controlled Information Television.

The committee also evaluated for HUD the latter's Urban Information Systems Inter-Agency Committee (USAC) Program, related to the experimental use of communications-information systems to improve city functions. Shortly before its transfer to the Assembly of Engineering of the National Research Council, the committee embarked on a study of the desirable framework for the evolution of the metropolitan communications network of the future, including such aspects as technology, economics, social ramifications, user wants and needs, and federal policy implications.

Disasters

The Academy's work on the subject of disasters has been diverse, ranging from the consideration of earthquake engineering to coal mine disasters.

The NAS/NAE/NRC Committee on Earthquake Engineering Research[46] was sponsored by the National Science Foundation to address the practical problems posed by earthquakes and discuss the research needed to solve these problems. The purpose was threefold: to describe the nature of the earthquake problem and the state of knowledge in the field; to indicate to research workers the areas where knowledge is lacking and where further research is needed; and to bring the earthquake problems to the attention of government agencies and other organizations that may initiate, direct, or fund research, and to provide them with information helpful in planning.

In view of the potential impact of destructive earthquakes on public safety and welfare, the continuing nature of the problem, and the expected increase of population and investment in construction, the committee recommended that a strong program of research be developed that is aimed at solving the major problems of safety and economy posed by the occurrence of earthquakes. The recommended research program was to address ten specific areas of concern, which included: the social and economic aspects of the earthquake problem which provide the basic motivation for earthquake engineering, as well as for earthquake engineering research; the problems of strong-motion seismology, including ground motions, required instrumentation, and necessary measurements; soils, foundations, and earth structures, which have been responsible for major disasters in past earthquakes; and structural dynamic analysis. Under the first area, one of the committee's five specific recommendations

---

[46]As its charge was expanded, the committee underwent several name changes, ultimately becoming the Committee on Natural Disasters (see page 132).

was that the cost-benefit ratio for earthquake protection should be determined. That is, evaluate the true cost of providing various degrees of earthquake resistance, and from this determine the economically proper investment to make for protection against earthquakes in the less seismic, as well as the more seismic, regions of the country.

An additional function of the Committee on Earthquake Engineering Research was to obtain information on the geological and structural effects of earthquakes through the use of on-site inspection teams which were dispatched immediately following the occurrence of such an event. Typical of such activity, which was also supported by the NSF, was the inspection made in Caracas, Venezuela, following the earthquake which occurred on July 29, 1967. Because of the quick reaction to the news of the earthquake, it was possible to observe and record a substantial portion of the critical structural damage before it was disturbed by operations of demolition or repair.

The Caracas earthquake occurred a few seconds before 8 p.m. local time, with a magnitude rated at 6.3 to 6.5 on the Richter Scale. The epicenter was placed at approximately 35 miles from the city. The characteristics of the ground motion in the city were unknown because there was no operational strong-motion instrument in or near Caracas at the time, but indirect evidence indicated that strong shaking continued for 15 to 20 seconds, with the whole event lasting about 40 seconds. Although Caracas was founded in 1567, the major portion of its development was recent. Consequently, it contained a very high proportion of modern construction, including over 7,000 structures of four stories or more, all but a few of these having reinforced concrete frames. There were only a few buildings with intentional shear walls, and filler walls of brick or tile, used liberally, were assumed not to affect structural response.

A total of eight major buildings collapsed and over 200 buildings were damaged, with a loss of life exceeding 275 persons. One of the more significant features of the structural damage was the salient effects of "overturning moment" or vibratory forces which tend to make a building rock upon its base. A routine application of methods embodied in most seismic design codes to the damaged structures in Caracas would not have highlighted the overturning-moment effects. The committee recommended that this feature of the codes needed reevaluation in light of evidence from Caracas. Another significant feature of the observed damage was the interaction of "nonstructural" filler walls with structural frames which produced a structural response quite different from the idealized response on which the design calculations were based. The committee recommended that this phenomenon should also receive attention in designing buildings and in revising pertinent building codes.

The Committee on Mine Rescue and Survival Techniques, an ad hoc unit, was established in March, 1969 at the request of the U.S. Bureau of Mines to conduct a study program to assess the technological capabilities that can be applied to survival and rescue techniques following coal mining disasters. Initially, the study was to be conducted in three phases. In the first phase a mine rescue and survival system that could be developed in one year from existing technology would be defined. In the second phase a more advanced system that could be realized with a five to seven year research and development program would be planned, and in the third phase the necessary research and development program would be planned.

In designing the first phase or interim system, however, much of the basic data necessary to design the second phase system was found to be unavailable, e.g. specific knowledge of the conductivity, seismic characteristics, and drill strength of strata overlying coal seams; the metabolism and respiratory rates of men striving to escape or reach chambers, or at rest within refuge chambers, etc. The second phase of the study accordingly was modified to be devoted to planning the research and development program to acquire the needed data from which an advanced system could evolve.

The interim system proposed by the committee consisted of a survival subsystem using improved emergency breathing devices and refuge chambers, a communications subsystem using seismic or electro-magnetic devices to locate and communicate with survivors, and a rescue subsystem of large- and small-hole drilling equipment and rescue teams. The characteristics of each subsystem were described in some detail. The facets of the research and development program recommended by the committee as a prerequisite to the development of an advanced system concerned the same subsystems, and included:

- Survival Subsystem -- expanded efforts in modeling mine explosions; investigations of oxygen storage, carbon dioxide removal agents, and chemical light sources; production of easily installed, strong long-life bulkheads and shelters, considering new materials such as fiber glass and rigid foam.

- Communications Subsystem -- improved electro-magnetic communications, including hybrid systems using through-the-ground and over-the-surface communications paths; development of new seismic techniques, including resonant transducers.

- Rescue Subsystem -- development of infrared and other spectral detectors for fire and hot-spot location; development of bubble-type helmets to provide rescuers better visibility and greater comfort.

Certain of these recommendations have been carried out by the Bureau of Mines, including prototype shelters and bulkheads and new communications subsystems.

Education and Manpower

During the latter part of the NAE's first decade, the engineering profession was subject to various criticisms: that technology has been applied at the expense of unacceptable social costs; that the profession has not responded adequately to minority aspirations; that there are gross failures in the application of promising technology to such social problems as education; and that having accepted massive governmental efforts in technology, the profession was not prepared to cope with manpower dislocations resulting from shifts in the nature and scope of government programs. The Academy has addressed these considerations.

Concerned with the broader aspects of technological education, the Academy's Commission on Education conducted a national workshop, with support from the National Science Foundation, to consider new directions for engineering education. This resulted in a workshop memorandum entitled "Social Directions for Technology", and served to stimulate and encourage efforts that were beginning or that were underway to balance the technical emphasis of the engineering curriculum by introducing social, political, and economic considerations.

The commission encouraged student involvement in technological design competitions which brought into play technical, social, legal, and economic issues, and acted in an advisory capacity to SCORE -- Student Competition on Relevant Engineering. It also continued its support of a program designed to bring an understanding of engineering concepts to non-science students in the secondary schools.

And, with support from the Department of Health, Education and Welfare, the Commission on Education developed a planning document to take a systems approach to delineate the major policy issues in educational technology. The study also assessed the implications of selected alternatives and recommendations on priorities for short- and long-term activities by HEW's Office of Education.

In May, 1973, the Academy held a Symposium on Minorities in Engineering, in connection with its Thirteenth Annual Meeting, and under the aegis of the commission. As a direct result of the symposium, a program for increasing minority participation in engineering was established which included three operating levels of volunteer effort; namely, a National Advisory Council on Minorities in Engineering, a Committee on Minorities in Engineering, and four specific subcommittees. The four subcommittees are concerned with pre-engineering motivation and guidance, engineering education, manpower utilization, and finance. This program, financed by private grants, has as its goal to increase minority enrollments in engineering by ten-fold within ten years.

Sharp shifts in governmental priorities beginning in the late 1960s produced severe employment problems for the scientific and technical community. The loss of existing and potential technical talent had particularly adverse implications for a technologically based society. Using its independent funds, the NAE accordingly established the ad hoc Committee on Engineering Manpower Policy to study specific aspects of the problem of under-utilization of engineers and scientists, such as the movement and re-employment patterns of engineers, the availability and dependability of manpower data, and long-range effects and possible solutions for underemployment. The Academy recommended several steps for effective manpower management including the incorporation of manpower considerations in the annual budget cycles of cabinet departments and major agencies; an oversight group, perhaps located within the Executive Office of the President, to aggregate the assessments of governmental programs; and a continuing and direct involvement in manpower planning by the scientific and technical community.

In February, 1974, the Board on Engineering Manpower and Educational Policy was established as a successor to the Commission on Education with a substantial expansion in scope of activities. The board was intended specifically to respond to the need to define a manpower policy designed to result in more efficient utilization of engineering manpower resources in the U.S., and to study and advise on national policies concerning or affecting technical education in general and engineering education in particular. The initiation of the board's activities was supported through use of NAE independent funds.

Energy and Natural Resources

The formulation of national resource and energy policies must be predicated on an appreciation not only for what technology can do, but also on what is practicable in terms of manpower, capital requirements, governmental action, and institutional constraints. Expert assessments of alternative technologies are required to optimize progress toward specific goals, as are social mechanisms for choosing and implementing technological options.

The Academy's self-sponsored Task Force on Energy, formed in December, 1973, conducted an assessment of realistic steps that might be taken to increase domestic energy supplies and decrease consumption during the next decade. The study

entailed an examination of the practical engineering feasibility and probable output of major production programs in specific energy areas, including the identification of major actions that would be needed by government and industry to initiate and implement them, and an appraisal of their physical, technical, cost (money, resources, and environment), and schedule aspects. However, there was no attempt to pass judgment on the overall desirability of the various programs, including their social and economic consequences.

The study concluded in part that providing additional domestic energy supplies during the next decade or so does not require the solution of significant technical problems, but will, in some cases, call for substantial development support. The interrelationship between government and industry must be strengthened. The government must establish a well-defined national energy policy, including appropriate financial incentives and the removal of institutional roadblocks, and carry out its licensing and regulatory actions so as to attract large sums of private capital for investment in the programs while, at the same time, protecting the public interest.

In order to reduce the gap between energy supply and demand by 1985 to the extent possible, the study estimated, would require $500 to $600 billion in direct costs in 1973 dollars; more water resources than presently available, particularly in the western part of the country where there is exploitable oil shale and low-sulfur coal; and several hundred thousand more trained people, including engineers, to supplement the present energy work force.

The report highlighted the fact that if the U.S. wishes to be reasonably independent in energy resources by the mid-1980s there are in fact essentially no choices -- all programs possible must be carried out immediately and simultaneously. The report has been of very great interest to policymakers in government and industry, and close to 7000 copies have been distributed since it was issued in May, 1974.

Another successful energy-related study, mounted earlier by the Academy, was that of the Committee on Power Plant Siting (COPPS). Funded by the Atomic Energy Commission, the National Science Foundation, and the electric utility industry as a whole acting through nine Regional Electric Reliability Councils, the committee investigated means for resolving conflicts between the provision of electricity supplies adequate for the nation's requirements and the protection of

environmental quality consonant with public goals. The program had three major thrusts. The first was to identify those conflicts, issues, or questions in power plant siting where good engineering can help to avoid adverse effects on the environment by proper and timely consideration of environmental impact, taking due account of environmental science and value judgments in the engineering process. The second was to appraise the adequacy of existing or proposed approaches to power plant siting by giving attention to existing methods of setting environmental standards, technological methods for controlling environmental impacts, and promising methods of systems analysis and synthesis. The third thrust was to identify those areas where further study, research, or development seem likely to improve methods for power plant siting.

As the result of this intensive 16 month effort, the committee evolved some 50 major recommendations for early action. Paramount among these was the recommendation that agencies should be established to act with finality, subject to due process of law, on power plant siting issues through unified procedures that give comprehensive considerations to all factors relevant to the public interest and to the views of all concerned parties. This certification function should be exercised at the lowest governmental level that has adequate jurisdiction, and that can marshal the required technical and other competence. The study report makes clear that in the short term, major developments for environmental protection would be the result of changes in regulatory and operating procedures, and that in the longer term, developments would depend upon the results of r&d.

While no implication is made that the NAE was the principal factor in these accomplishments, most of the states have enacted legislation and have established agencies to decide power plant siting issues generally along the lines of the COPPS recommendations, including provision for public participation, as exemplified in Illinois, New York, Ohio, and Washington. Similarly, energy research and development is emerging generally along the lines of COPPS recommendations for a comprehensive multi-disciplinary approach with heterogeneous but coordinated participation as evidenced in the Energy Research and Development Act.

The increased cost and limited availability of fuels and natural resources, the sharpened public concern about environmental impacts, and the growing emphasis on life cycle costs are important factors that encourage a search for alternatives to conventional utility systems. One alternative is the integrated

utility system. A successful integrated utility system using traditional "wastes" from utility processes would provide utility services that conserve energy and natural resources, while simultaneously achieving a high level of customer satisfaction, competitive costs over its life cycle, and full compliance with all environmental standards.

The Integrated Utility Systems Board was established at the request of the Department of Housing and Urban Development to undertake a review and evaluation of various integrated utility concepts, emphasizing those concepts being developed by HUD with a view toward demonstration. Because these integrated systems can be considered "modular" in some sense, the program was given the acronym "MIUS" (Modular Integrated Utility Systems), and focused on residential/commercial applications in the size range from 300 to 1,000 dwelling units. The board focused its attention on four major areas: determination of the technical feasibility of complete systems, components, and sub-systems; evaluation of alternative concepts with regard to costs, environmental impact, energy savings, and other criteria; identification of potential institutional constraints or incentives which may impede or encourage implementation; and formulation of effective plans and strategies for conducting demonstrations.

On the basis of this effort additional studies were judged to be needed to develop improved concepts which are suitable for demonstration, to provide data useful in the planning of demonstrations, and to furnish information needed to encourage private sector interest. The board made nine specific recommendations concerning the HUD-MIUS program. Among these were further investigation of subsystem integration concepts; support for the development of innovative technology which can become commercially available within the near term, and which reduces reliance on oil and gas; additional studies on economic feasibility, cost/benefits, compliance with environmental standards for different applications; development of mechanisms to deal with institutional problems; and establishment of priorities among demonstration objectives.

Environment

Controlling and improving the quality of environmental resources is a growing concern of the nation. National and regional air quality management standards are being defined, but with the realization of the formidable capital investments that

will be required. The challenge is to minimize such costs, while still attaining an acceptable level of control within the shortest practical time span.

Among those NAE activities concerned with environmental matters were three grouped under the title, Committees on Pollution Abatement and Control, which represented a joint effort of the Academies and the National Research Council. These committees, frequently operating through the mechanism of ad hoc panels, dealt with management of air quality, solid waste, and water quality. The work of the first, described below, is representative.

The work of the ad hoc Panel on Abatement of Particulate Emissions from Stationary Sources was supported by the Office of Air Programs of the Environmental Protection Agency (EPA). Continuing deterioration of visibility in urban areas, together with the possibility of unfavorable climatic and health effects, had led to a renewed concern for controlling particles in the atmosphere. The panel's report outlined a program of relevant government and industry research that was deemed necessary.

The panel estimated that at the 1970 level of control, particulate emissions from industrial sources would increase from 18 million tons per year to over 50 million tons per year by the year 2000. Although existing methods for the removal of particulate matter from gases were considered adequate for the control of the greatest part, by weight, of the emissions from stationary sources, the panel found that it might not be sufficient to evaluate the performance of pollution-control equipment on the basis of mass emissions alone. This was because particle size, composition, and the presence of co-contaminants must also be taken into account, with special emphasis needed on the amount of material in the fine-particle size range and on its chemical nature. The panel's six recommendations included the development of collaborative federal programs with gas-cleaning equipment manufacturers and users to obtain basic engineering performance data on particle-collection equipment as a function of particle size. The panel further recommended that engineering research and development on particle-control technology be intensified, with special emphasis placed on the 0.2 to 2.0 micron diameter range, and that improved methods be developed to relate the characteristics of emission sources to atmospheric particulate pollution.

A major study of the Committee on Air Quality Management was an evaluation of coal gasification technology for the Office of Coal Research, U.S. Department of Interior. Prompted by the declining rate of gas discoveries in the continental U.S.,

accompanied by a continually increasing demand, an ad hoc panel conducted a two-part study of the engineering and operating problems associated with coal gasification processes. The first phase of the study examined eight processes for the production of pipeline quality gas (i.e., 1,000 Btu per scf). It was considered necessary to turn to coal as one long-term source for a substitute gaseous fuel, since supplemental sources of natural gas from Canadian and Alaskan fields and the importation of liquified natural gas were not expected to fully avert the enormous deficiencies of natural gas projected for the 1980-90 period.

The panel cautioned that it would be unrealistic to expect that the projected short-fall could be made up entirely with synthetic gas from coal, primarily due to the lack of capacity to produce in sufficient quantity the specialized equipment required. The panel concluded, however, that the critical U.S. natural gas situation justified maximum governmental and industrial effort to develop quickly the most economic methods for providing supplemental pipeline quality gas from coal. Because of the need to reach commercial application of a modern process as quickly as possible, it recommended the simultaneous development of the Hy-Gas, Synthane, Acceptor, and Bi-Gas processes up to the point of making a decision on demonstration plant construction. The justification for this recommendation was that each gasifier, the most critical component of each process, has unique features of potential economic importance.

The second phase of the study was concerned with the production of a lower-cost gas suitable for power generation and large-scale industrial use, but too low in heating value (i.e., 150 to 450 Btu per scf) to be transportable over long distances. Coal gasification to produce low- to intermediate-Btu content gas was considered for three technical and economic reasons: the advantage of purifying a small volume of high pressure flue gas over purifying a large volume of stack gas; the relative simplicity of flue gas (containing H_2S) and stack gas (containing SO_2) purification methods; and gasification followed by purification as offering one means of meeting air quality standards.

Based on its study and review, the panel concluded that a clean-burning low- or intermediate-Btu gas from coal would be a highly desirable fuel for many applications. It recommended that vigorous research and development work on production methods be started, and on a large scale. It was estimated that government support of at least $300 million over a five-year period would be needed. An additional recommendation was for the separation of the overall gasification process into its individual process steps, and, whenever feasible, the assignment of each step to one or more groups for intensive development.

The ad hoc Panel on Abatement of Sulfur Oxide Emissions from Stationary Combustion Sources was sponsored by HEW's Air Pollution Control Administration. In a study issued in 1970, the panel noted that SO_2 emissions from the combustion of sulfur-bearing coal and oil, primarily for electrical energy generation, is second only to internal combustion engines in the quantity of pollutants discharged, and the national electricity energy requirement is expected to more than triple in the next 20 years. The substitution of low-sulfur fuels, the only available method for reducing SO_2 emissions, is restricted by the limited availability of such fuels, and the more rapid application of nuclear energy is constrained by engineering, economic, and siting problems. The panel therefore concluded that reducing SO_2 emissions from stationary sources will largely depend on the development, demonstration, and application of technologies which prevent the sulfur in fuel from reaching the atmosphere through combustion. After reviewing the status of American and foreign processes, the panel concluded also that commercially proven technology for sulfur oxides control from combustion processes did not exist. Its recommendations for a five-year plan placed highest emphasis on the development of the limestone process for SO_2 removal from stack gases because of its broad applicability, and research on ways to combine the abatement of nitrogen oxides and particulates with sulfur oxide control.

The EPA Office of Air Programs similarly supported the work of the ad hoc Panel on Abatement of Nitrogen Oxide Emissions from Stationary Sources. The nitrogen oxides emitted from industrial sources, defined as NO_x for convenience, include nitric oxide (NO) and nitrogen dioxide (NO_2); nitrous oxide (N_2O), believed to be innocuous at the levels commonly emitted, is excluded from the definition. The largest stationary-source emittors are fossil-fueled boilers of electric utilities and industrial furnaces. At 1970 control levels the NO_x emissions from these sources are expected to double by the year 2000.

In its conclusions the panel cited the application of some combination of combustion-modification processes to reduce the NO_x formed as most promising to achieve significant early reduction of NO_x in fuel-combustion stack gases. However, the probability that processes can be developed for the removal of NO_x from stack gases was not thought encouraging. The panel accordingly recommended that combustion modification studies be given first priority in research and development to control NO_x emissions, with studies of coal combustion being especially required. Studies of the effect of fuel nitrogen on NO_x emissions and the potential of combustion flame temperature control techniques were also recommended.

The Technical Session of the Academy's 1969 Annual Meeting was devoted to development planning -- initiatives the NAE might undertake -- and deeply involved the NAE membership. The Committee on Engineering Aspects of Environmental Quality, later the Committee on Environmental Engineering (CoEE), was established in February, 1970, as a result of member recommendations emerging from workshops held during that meeting. The committee was expected to pinpoint critical environmental problems and set in motion mechanisms for clarifying and defining the issues to be resolved.

The CoEE was instrumental in launching the Academy's power plant siting study (see page 31). Subsequently it undertook an analogous project to distill from the COPPS study a set of guides that would be useful in decision-making by regulatory agencies, energy industries, and citizen groups. Although not formally published, the results of this modest effort, termed "Explicit Criteria for Decision: Background Papers", included several suggestions for possible future Academy studies.

The CoEE conducted a brief study for the Naval Civil Engineering Laboratory to appraise the probable effectiveness of the Navy Environmental Protection Data Base (NEPDB) in providing the means by which the Navy monitors and evaluates operations so as to protect and enhance the quality of the environment, and enable compliance with environmental laws and regulations. The NEPDB was designed as a system for world-wide acquisition and management of information regarding the environmental impacts of various Navy activities -- of the fleet, the air arm, shore installations, and ancillary services such as hospitals and ordnance plants.

On the basis of adopted policies and plans, and of limited observation of operational performance, the study concluded that NEPDB as planned can become an adequate and centralized system for acquiring and managing information regarding Navy compliance with established environmental standards. This was, however, provided that the potential usefulness of the system is recognized by decision-making officials, and provided that funding and personnel requirements are adequately supplied. Among the 19 general recommendations stated in the study was that the NEPDB system should provide for feedback procedures that will develop information on the effectiveness, at all levels of command, of the environmental data acquired and disseminated in meeting the objectives of the Navy Environmental Protection Program.

Health

In 1967, with core support from the National Institutes of Health, the NAE established the Committee on the Interplay of Engineering with Biology and Medicine (CIEBM) to examine means to enhance the utilization of engineering concepts and technology in the development of instruments, devices, and materials relevant to biology and medicine. Similarly, under contract to NASA, the committee sought to identify aerospace engineering technology applicable to specific technological requirements in the biomedical field. These efforts divided into several related themes: analysis through university subcontracts of industry/university/community cooperation in the development and utilization of biomedical technology; industrial aspects in biomedical engineering; engineering in clinical care; the appraisal of biomedical engineering efforts in several foreign countries; and the assessment of biomedical technology to provide sensory aids for the visually and hearing impaired.

University prototype studies were employed to study how effective relationships among industry, the community, and the university could be established which could optimize the solution of urgent problems in medicine and health care. The studies led the participating universities to develop mechanisms for collaborative efforts between university engineering and bioscience departments, industry, and the health care delivery components in the community. For instance, they contributed to the creation by Ohio State University of the Central Ohio Biomedical Engineering Community Council (COBECC). COBECC is a seven-county, non-profit organization that appeared to be an effective mechanism for stimulating interaction among the university, medical professions, health-care institutions, professional societies, and industrial firms. As a direct result of its participation in the prototype studies, the University of Wisconsin also developed a positive program which included contract work with NASA.

Other aspects of the committee's work were equally successful and effective. For example, the chairman of the Subcommittee on Sensory Aids, which issued several reports that attracted considerable attention, testified before both houses of Congress. The final report of a study of aerospace technology utilization in the civilian biomedical field, prepared for NASA, was entered into the record of the oversight hearing on the Vocational Rehabilitation Service Bill of the Rehabilitation Act of 1973, and has had a direct influence on the course of rehabilitation services.

Many of the recommendations which resulted from the study of aerospace technology transfer are being implemented. The major contribution of this work, however, has been in developing the awareness that NASA must do considerably more than merely make technical information available to the civilian sector. Of prime importance is interaction with the medical community to conduct developmental work and perform clinical evaluations in order to adopt and modify the relevant technology as necessary. As a direct consequence of the foregoing, Tufts College Medical School engaged in a project to apply a planetary life detection technique based on the use of ATP-luciferase for determining antibiotic susceptibility. And, consonant with the committee's recommendations that NASA could "lend intellect" as well as provide new black boxes to the health care field, the space agency has contributed technical consultation to the Maryland Division of Emergency Medical Services.

A request from the National Highway Safety Bureau of the Federal Highway Administration led the Academy, through its Committee on Ambulance Design Criteria, to undertake a project to develop design and performance criteria for ambulances. A group of eminent physicians, ambulance operators, automotive engineers, and specialists in related fields were assigned to work in five areas of concern: a comprehensive system description; operational hardware and equipment; vehicle standards; communication equipment; and environmental equipment. The standards developed by each subcommittee in its own area of responsibility were then further developed by the entire committee into specific design criteria. These design criteria were enumerated in a system description format having 33 classes covering features ranging from specific vehicle design and performance standards to special equipment for use by the physician or trained attendant.

Land and Housing

The NAS and the NAE jointly created an Advisory Committee to the Department of Housing and Urban Development (ACHUD) to assist that department in fulfilling its legislative mandate in the field of housing. A Social Science Panel attached to both ACHUD and the division of Behavioral Science/NRC was formed in 1970 to assimilate and assess the behavioral and social science knowledge bearing on the feasibility and desirability

of a policy of social mixing, both at the neighborhood level, and in metropolitan areas as a whole. The term social mixing embraces the degree to which racial and ethnic minorities are interspersed in residential communities (i.e., racial mixing) and also the patterns of stratification of urban areas on the basis of income, occupation, and education (i.e., socioeconomic mixing). Due to the meager information available concerning socioeconomic mixing the emphasis of the panel's work was on the forces and experiences of racial integration.

The panel formulated ten specific recommendations, the first of these being that, in light of conclusive evidence on its feasibility, the primary emphasis of a policy of social diversity in housing should be on opening options for racial mixing of those with similar economic capabilities. A series of carefully planned experiments to determine the condition under which residential mixing of families or individuals of different racial and economic categories may be feasible was also recommended.

The Land Use Subcommittee of ACHUD was formed to examine the relation between land development and the problems resulting from urbanization. The scarcity of knowledge about the import or impact of land development processes, or the changes in density and use of developed land, dictated the group's study priorities.

The subcommittee recognized that land development problems, while important, were not yet crucial, and therefore hesitated to recommend a national urban growth policy based on the consideration of such problems. It specified five criteria for the allocation and distribution of federal funds, and recommended that the federal government fund several essential research projects which would include the development of a raw land price index, and a more precise understanding of the factors affecting the price of land and their interrelations.

One of ACHUD's early assignments, through a technical panel established for the purpose, was to provide guidance in the technical aspects of Operation BREAKTHROUGH, an effort whose primary objective was to establish mechanisms to mass-produce and mass-market housing for families at all income levels, but particularly for those of low and medium incomes. The program's secondary objectives included stimulating the modernization and broadening of the housing industry and encouraging the identification and development of performance standards for the evaluation of innovations.

The study concluded that the objectives of Operation BREAKTHROUGH were not fully achieved, although the program did contribute in initiating efforts toward a number of those

objectives and in advancing housing technology generally. The committee suggested that HUD should pursue an expanded version of its program to document events involved with Operation BREAKTHROUGH, and seek feedback data from the program.

With ACHUD initiative, the Division of Behavioral Sciences/NRC in 1971 established a Panel on the Significance of Community in the Metropolitan Environment which undertook to set forth the current knowledge of urban organization and life. The panel recognized the deficiences in knowledge relating to the task and accordingly commissioned a series of ten state-of-knowledge papers on which it drew heavily during its deliberations. The panel also sought to understand the policy context of HUD, and to secure relevant information from its representatives. This panel concluded that an expanded but sharply focused research effort was essential to provide the basic understanding required for the formulation of innovative policies. It enumerated the following research problems for priority consideration for funding: demographic movement, metropolitan governance, intrametropolitan circulation, residential choice, urban experience, community satisfaction, and micro-community.

The ACHUD's Subcommittee on the Planning Process and Urban Development dealt with the status of local planning capabilities in light of a more varied federal domestic program inventory, altered by the advent of general and special revenue sharing. The subcommittee examined the forces that led to the departures from federal domestic programs based upon categorical grants and identified certain mismatches that had compromised the effectiveness of the existing planning process. Those mismatches included the incongruity between nationally defined goals and locally perceived needs and priorities, and the disparity between verbal assignments of priority and the commitment of funds, personnel, and energy.

The primary recommendation emerging from this study was for a well financed and continuing program to enhance the planning and management capacity of state and local governments and metropolitan agencies. The subcommittee further recommended a parallel but related program of assistance to communities for developing techniques and personnel to implement plans, including the integration of the planning process with the political decision-making process.

The NAE's Committee on Industrialized Housing was established in December, 1970 under a grant from the Scaife Family Charitable Trusts. The committee's task was seen from the outset as part of a broad-based public and private commitment to provide improved shelter. The Industrialized Housing Project was viewed as an appropriate vehicle for exploring one major, quantifiable element in a complicated social problem. The major purpose of the committee, in simplest terms, was to see if manufacturers could make and people would buy houses, either as complete units or in modules, in much the same way that automobiles are manufactured and sold.

The project was conceived as an analysis and test of economic and social indicators which seemed to support the assumption that cooperation among the nation's leading industrial corporations in the mass production of housing was essential and would prove sufficiently profitable to attract investment capital on the scale required to launch a new, high-technology industry. Significant among these indicators were: the magnitude of the housing problem; the role of improved construction methods in a variety of successful European housing programs; and increasing confidence in the effectiveness of technology transfer. In preparing its report the committee relied heavily on technical staff made available to it by several of the nation's largest industrial organizations. In addition, it made extensive use of experts from government departments and universities, as well as consultant-contractors representing a variety of relevant disciplines.

The committee's findings concerning the major economic and social indicators were detailed in its report; various of these are presented here. On the basis of the levels of housing production reached in 1970 and 1971, and those projected for 1972, it was clear that federally-mandated production goals could be met or even exceeded by the existing mix of conventional builders and mobile home and other semi-industrialized producers. In the 1950s and 1960s, a number of European countries made impressive gains in overcoming housing shortages by aggressively converting from conventional to highly sophisticated industrialized housing production systems, often with demonstrated cost superiority over the traditional home building techniques. The project found, however, that the degree to which the European industrialized housing experience could be applied in this country did not at that time appear to merit major investments in production facilities by American manufacturers. The committee further found that comparison of the home building process with the automobile industry was useful only as a theoretical exercise. It was concluded that problems of transportation and distribution were insurmountable with the facilities then available.

The committee report noted that, in general, there was a movement toward building and buying increasingly large components of houses; e.g., kitchens, bathrooms, roof trusses, etc. It expressed the view that changes in this direction would continue and, indeed, ought to be encouraged; presumably, with the passage of time the original goal would be met.

Marine

For over 15 years, growing national interest in the marine environment has created a demand for a continuing effort to collect and evaluate the varied body of scientific and technical knowledge of the ocean and to apply this knowledge for the benefit of society. The important role of engineering in the development of the ocean's resources has long been recognized. In April of 1965, the National Academy of Engineering established a Committee of Ocean Engineering (NAECOE) to furnish advice as to the organizations, facilities, and programs that would be most appropriate for executing the statutory responsibilities of the government with respect to utilization of the resources of the ocean and to the technological application of oceanographic knowledge to public welfare and defense.

This new committee had the support and encouragement of four federal agencies concerned with developing a national oceanographic program -- the Departments of Navy, Commerce, and Interior, and the National Science Foundation. Since its beginning, it has undertaken more than 54 projects at the request of various government agencies concerned with ocean engineering problems. Many projects have been conducted jointly with the closely-related National Academy of Sciences Committee on Oceanography (NASCO, now the Ocean Affairs Board).

In October of 1970, the Committee on Ocean Engineering was designated the NAE Marine Board in recognition of the long-term interest in marine affairs and the importance of providing engineering advice in formulating national policies. Like its predecessor, the Marine Board continued to study the development of ocean engineering capability, the utilization of ocean resources, and the role of ocean engineering in national and international affairs. The sponsorship of the board was broadened to include the Department of State, the Environmental Protection Agency, the Corps of Engineers, and the U.S. Coast Guard. Some of the major projects undertaken by the Marine Board and the parent Committee on Ocean Engineering are outlined below.

The first important task addressed by NAECOE involved a comprehensive study of the role of professional engineering in management and development of the marine environment. Supported by the committee's original sponsors, the study was conducted over a period of several years by the committee and nine sub-panels which together addressed a broad range of ocean engineering concerns. These long-range deliberations provided the groundwork for many future Marine Board projects. The final report, completed as a Marine Board project, was entitled "Toward Fulfillment of a National Ocean Commitment". Published in 1972, the report presented an overall picture of the economic, social, environmental, and political manifestations of a national engineering policy in both the development and effective utilization of marine resources.

Recognizing the necessity to restore and maintain the environmental quality of the coastal zone, NAECOE then began a study of the effective management of wastes resulting from increased coastal zone development. A symposium on coastal wastes management was held in July of 1969 at Jackson Hole, Wyoming under the aegis of both NAECOE and the NASCO. An expressed interest in the work of the symposium came from the Federal Water Pollution Control Administration (FWPCA, now EPA's Water Quality Office) which itself was conducting a study of coastal area pollution. The results of the symposium study were used by the FWPCA in its report, "The National Estuarine Pollution Study", issued November, 1969. The recommendations of the symposium also were incorporated in a formal NAS/NAE report issued to the public, entitled "Waste Management Concepts for the Coastal Zone -- Requirements for Research and Investigation".

Another major project undertaken jointly by NAECOE and NASCO was a study to identify programs of exploration which best would contribute to advancing society's efficient utilization of the ocean's resources. This national policy study was to be a part of an International Decade of Ocean Exploration (IDOE), first proposed by President Lyndon B. Johnson on March 8, 1968. At the request of the National Council on Marine Resources and Engineering Development, the two committees were invited to provide advice on the scientific and engineering aspects of U.S. participation in such an effort. A comprehensive report on the goals and programs of IDOE was issued by the committee in June of 1969 under the title "An Oceanic Quest: The International Decade of Ocean Exploration". NAECOE consequently proposed the formation of an Engineering Committee on Oceanic Resources, which would function as an independent, international, and non-governmental engineering advisory organization. Known as ECOR, this group is still in operation today, providing an international focus for professional engineering interests in marine affairs.

In 1970, the assistance of the NAECOE was solicited by the Department of Interior following a devastating fire on a drilling platform operated in the Gulf of Mexico by Chevron Oil Company. Again in conjunction with NASCO, a joint ad hoc panel was established to study the disaster and to provide both immediate and long-term recommendations. The final written report was issued within a month after the fire occurred.

As a follow-up to the problem of oil spills resulting from a platform disaster, the Department of Interior requested the Marine Board to study the engineering technology available to assist in minimizing major oil seepages, and the methods by which industry and government could implement preventative measures. Other federal agencies including the U.S. Geological Survey, EPA, the National Oceanic and Atmospheric Administration (NOAA), and the U.S. Coast Guard became interested in the objectives of the study. The resultant report, "Outer Continental Shelf Resource Development Safety: A Review of Technology and Regulation for the Systematic Minimization of Environmental Instrusion from Petroleum Products", was published in the spring of 1973. Basic recommendations included initiation of common technical definitions and standards; greater governmental involvement in research and in regulation; and new public exposure to incidents of oil spill accidents and near accidents. Pollution problems resulting from oil spills continue to be a concern of the board which, through its Committee on Safety of Outer Continental Shelf Petroleum Operations, issued two reports on the subject in 1974.

A major Marine Board project completed in mid-1974 addressed prospective engineering problems which would evolve from increased future use of data buoys for gathering and recording information. At the request of the Department of the Navy and NOAA, a Marine Board panel made an assessment of current data buoy technology and of needed research and development for a projected state-of-the-art by the end of the century. The panel's report, entitled "Directions for Data Buoy Technology 1978-1983", called for improvements in buoy and sensor testing and design and suggested some major changes in federal buoy programs. In essence, the report summarized the need for an orderly and effective development of data buoy technology in light of the important contributions data buoys could make in the future of exploitation of ocean resources.

Productivity

Productivity is a measure of efficiency, the ratio of output to input. Productivity is often difficult, if not impossible to measure, particularly in the service sector. If it can be measured, it can quantify how effectively resources such as materials, labor, and machinery are converted into the production of goods and services. The Academy's 1971 Annual Meeting was used as a vehicle to explore whether significant improvements of productivity could be achieved through the intensive application of technology. The specific objectives of the program were to identify potential improvements in productivity in the service sector through the application of technology; to determine important technological applications for increasing productivity in these areas; and to define experiments demonstrating the feasibility of applying technology economically and effectively in the areas of education, health care delivery, and urban services.

In the initial phase of the productivity program a one-day symposium was held, followed by three individual one-day workshop sessions. The latter phase consisted of several task group meetings composed of key participants from the individual workshop sessions. Two main objectives were accomplished in the course of the symposium, the three workshop sessions, and the subsequent task group meetings: (a) the generation of both general and specific recommendations for how technology can be applied in each of the three service sectors for the improvement of productivity; and (b) the development of four proposals delineating the scope, objectives, approach, and resource requirements for implementation of four selected recommendations.

The needs identified by the participants in the workshop on education included the development of more effective methods for the measurement of educational system outputs, and also the development of more effective evaluation methods for determining both educational productivity and cost effectiveness, including the appraisal of educational experimentation and innovative change. The workshop on health services identified the need for continued development and wider utilization of computer models for hospital administration, cost control, storage and retrieval of medical histories, and balancing of hospital services in accordance with community demographic and morbidity data. The needs identified by the urban services workshop were grouped into the four following categories: urban modeling and simulation, integrated utilities systems, communications, and transportation.

As a result of the efforts of the urban services workshop, a proposal for the establishment of an Integrated Utility Systems Board (IUSB) was prepared for submission to the Assistant Secretary for Research and Development at the Department of Housing and Urban Development. The proposal's acceptance by HUD resulted in the formation of the Academy's IUSB, a description of which is included under the section "Energy and Natural Resources" (see page 32).

Public Engineering Policy

The Committee on Public Engineering Policy (COPEP) has led the Academy's involvement in the public policy arena. COPEP has emphasized goals, strategies, and institutional considerations in its examination of options for decision makers. Special attention has been given to ways and means to improve the utilization of results from technological undertakings. To deal with the entire setting of technology in use, tools for technology assessment and for benefit-risk analysis have also been sharpened, and focused on both the direct and indirect effects of new technologies on society.

At the request of the House Committee on Science and Astronautics, COPEP undertook a study of the utility and practicality of the concept of technology assessment. As part of the study, it conducted three experimental technology assessments in relation to teaching aids, subsonic aircraft noise, and multiphasic health screening. (The three assessments were based respectively on the work of Task Forces of the NAE's Commission on Education, the Aeronautics and Space Engineering Board, and the Committee on the Interplay of Engineering with Biology and Medicine.) Study panelists concluded that useful methodologies are available, that more adequacy can be developed through practice, and that therefore, technology assessment can help decision makers perceive, appraise, and initiate actions required to secure the greatest values from technology. The published report of the study contributed to the legislation that ultimately created the Congressional Office of Technology Assessment.

A COPEP colloquium entitled "Perspectives on Benefit-Risk Decision Making" was convened to explore means for formal evaluation of decisions involving risks and benefits affecting human health and safety. The White House Office of Science and Technology, the Senate Commerce Committee, and the House Science and Astronautics Committee co-sponsored

the colloquium with financial support provided by NSF, the Atomic Energy Commission, and Departments of Commerce, HEW, and HUD. Although precise benefit-risk analysis was judged to be extremely difficult, the published study report reflected the development of basic criteria for any benefit-risk analysis. These criteria included interpretability, universality, consistency of value statements, and openness of the process.

In the first of two related studies for the Research Applied to National Needs (RANN) program of the National Science Foundation, COPEP assembled nearly 100 individuals from a broad variety of disciplines, experiences, and sectors of society to address the issue of priorities for applied research. The effort evolved 31 ranked recommendations distributed across six broad categories: community development and human resources; environmental quality and economic growth; conservation of energy, materials, and land; new production processes; hazards and disasters; and exploratory development and other technological opportunities. In addition to the 31 recommendations for research support, two over-riding themes of "institutional functioning" and "conservation and patterns of consumption" were emphasized. A high, although not complete, correlation has been noted between COPEP's recommendations and the RANN plans for fiscal years 1974 and 1975.

Three panels of experts met under the auspices of the National Academy of Engineering in April, 1970, to address the topics of world population and world nutritional resources, and to review the barriers to fuller application of existing technology in balancing these factors. The panelists presented their findings at a symposium on "The Food-People Balance" held in connection with the Academy's Sixth Annual Meeting (see Appendix VIII). It was concluded that equilibrium could be achieved through technological innovation and resource conservation in combination with population control. However, it was observed that achieving the food-people balance first required understanding of the total system -- ecological, sociological, biological, financial, cultural, and political, as well as technological.

In order to create a greater awareness of technological options and limitations for feeding a hungry, crowded world, COPEP in July, 1974,[47] conducted a seminar on "World Hunger: Approaches to Engineering Actions", as a follow-up to the

---

[47]The seminar was held on July 10, 1974, ten days after the transfer of COPEP into the Assembly of Engineering of the reorganized NRC. However, the planning phase of the session was accomplished while COPEP was under the NAE.

1970 symposium. This was a timely action because by 1974 a combination of unfortunate circumstances -- bad weather, poor harvests, sharply rising prices for energy and fertilizer -- precipitated a world food crisis. In the course of only two years (1973-74) the world's food reserves had been reduced to a 22-year low.

The conclusions emanating from the seminar were that opportunities for engineering innovation lie in discovering new agricultural practices and techniques, in delivering necessary quantities of vital inputs such as fertilizer to farmers on time, in designing storage and transport systems to handle increased output, in enriching and preserving food, in developing new foods, and in packaging and marketing food products. The array of issues explored at the seminar confirmed the expectation that systems engineering inputs will be important in attacking the age-old problems of world hunger.

Technology and International Relations

Improving the efficiency and effectiveness of industrialization programs has become increasingly important not only to economic planning authorities in less developed countries (LDCs), but to political and opinion leaders as well. The reason for this heightened concern with types and techniques of production include the desire to save foreign exchange and other resources by developing a more efficient range of industries that produce, primarily for sale in the domestic market, goods that would otherwise be imported; and the desire to earn more foreign exchange by producing with the requisite efficiency goods that can be sold on world markets.

At the request of the U.S. Agency for International Development (AID), an ad hoc Advisory Panel on the Role of U.S. Firms in Strengthening Industrial Research, Development, and Engineering (R,D&E) Capabilities in Developing Countries was convened in 1971 under the auspices of the NAS Board on Science and Technology for International Development (BOSTID) in collaboration with the NAE. The panel brought together knowledgeable individuals to examine the past and potential role of U.S. firms in strengthening the R,D&E capabilities in developing countries, and to identify the principal factors tending to promote or inhibit such a contribution. The 15-member panel included 10 from industry, two from each of five sectors (automotive-farm implements,

chemicals, electronics-electrical products, food processing, and pharmaceuticals) and five academic members with professional interest in the subject.

The panel recognized that although the policies of each LDC will determine its relationship with the outside world, forward-looking behavior on the part of U.S. international firms could influence and help shape the policies that are ultimately adopted. The following were among the panel's key recommendations: all concerned should recognize that R,D&E is a complex, time-consuming, and costly activity that requires a stable, long-term, and open relationship between the host nation and the investor; U.S. firms should relate their affiliates' activities to host countries' development goals, priorities, and strategies; host countries should encourage this process and establish mechanisms that foster consultation and interaction among the government, the scientific sector, and the productive sector.

A critical challenge facing developing and developed countries alike in the near future is industrialization. Increases in population, food production, and mobility combine to present overwhelming needs for jobs, improved income distribution, and city-regional balance, which can be met only by new and better use of the world's resources, and to which effective industrialization is a vital factor. Again in response to a request from AID, the Academies of Sciences and of Engineering jointly convened a Special International Panel comprised of distinguished and knowledgeable persons from both developed and developing countries. The purpose was to examine the need, feasibility, and demand for an International Industrialization Institute (I^3) to perform research on new approaches to international industrialization that would benefit developing countries.

At its first meeting the panel outlined the general concept of the institute. To test the concept, the study director and a consultant from an industrializing country undertook a comprehensive series of interviews of key international organizations, and of individuals respected for their thinking on industrialization problems, particularly of the developing nations. The need for I^3 is based on the findings of the panel, which include: worldwide economic and social gains are great if there is an appropriate selection of industries among advanced and developing countries; the present lack of ability to evaluate alternative paths and policies for industrialization is apparent; the complexity of decision factors in industrialization is such that only intensive interdisciplinary research can illuminate the problem.

As the result of its study the panel unanimously recommended the creation of an autonomous, non-profit International Industrialization Institute, to be devoted to enhancing knowledge of the industrialization process, with the aim of helping both developed and developing countries to maximize the contribution of industrialization to their economic and social development and to share equitably in its benefits. The program of the Institute would emphasize applied research to create new linkages among policy, the market mechanism, and technology. Thereby would be help in guiding industrial decisions toward the selection of appropriate industries and technologies by countries of varied circumstances, and toward identification of policies to promote the growth of the selected industries as well as to enhance the capability of advanced economies for adjustment in accelerating desirable shifts of industries to new locales.

This concept has received no little attention within the Department of State as well as the United Nations. Practical support for its implementation has been expressed through the provision of AID funds to establish an ad hoc working group to advise AID and the State Department in their process of establishing the International Industrialization Institute. As this document goes to press, plans are proceeding to organize such a working group as a separate engineering activity within the Commission on International Relations of the National Research Council.

It should be noted and emphasized that in each of these endeavors there has been full dedication on the part of the NAS and NAE to the concept of freedom of scientific and engineering communication between nations irrespective of political or ideological beliefs.

Transportation

In August, 1970, under a contract from the Department of Transportation the NAE established its Committee on Transportation as a continuing activity to provide expert and broad counsel in the areas of transportation research, systems development and technology, and national/regional, modal/intermodal aspects and interfaces with other systems. The committee's first task was a study of urban transportation and the relation of systems and R&D as part of urban development.

The recommendations resulting from this effort included:

- further strengthening of professional capability both inside and outside DoT, to support adequately increased DoT research, development, and demonstration activity;

- supporting social science input and analysis to ensure proper design of urban transportation experiments and the implementation of more effective investment programs; and

- that the DoT consider taking the lead in encouraging state and local jurisdictions to effect program designs involving the overall physical and institutional transformations of one or several metropolitan areas as demonstrations of how changes in transportation can help fulfill broader social and urban objectives.

In part as the result of these recommendations, the DoT Transportation Systems Center at Cambridge, Massachusetts expanded its staff and research capability for monitoring demonstrations and for training. Emphasis was on the interdisciplinary aspects, particularly in systems analysis and in the social sciences. In addition, the committee's recommendations influenced the initiation of the DoT's Departmental Program of University Research, for which the committee provided counsel and guidance on a continuing basis.

Under a joint agreement, the DoT (acting as the lead agency), and the Department of Housing and Urban Development established and now fund and manage the San Francisco Bay Area Rapid Transit (BART) Impact Program. These agencies requested the NAE to establish a multidisciplinary committee which would provide recommendations concerning the design and later implementation phases of a program to determine BART's social, political, and economic impacts in the Bay area to gain an understanding of why these impacts occurred and how to determine the benefits from the Bay Area's investment in rapid transit. It was perceived that the results of the impact program could assist other metropolitan areas that are building or planning to build rapid transit systems. The recommendations made to DoT, in the main, have been all accepted and incorporated in the program. The committee will continue to monitor and review the progress of the implementation phase of the program for the next several years.

APPENDICES

APPENDIX I

MEMBERSHIP
of the
National Academy of Engineering
(as of May, 1974)

NATIONAL ACADEMY OF ENGINEERING

Membership
(as of May, 1974)

William C. Ackermann
Willis A. Adcock
Robert Adler
William G. Agnew
H. Julian Allen
Luis W. Alvarez
Gene M. Amdahl
Neal R. Amundson
Philip M. Arnold
Wm. Howard Arnold, Jr.
Holt Ashley
J. Leland Atwood
Isaac L. Auerbach
James B. Austin
Charles F. Avila
Albert L. Babb
Walter C. Bachman
Vinton W. Bacon
Stuart L. Bailey
Roy Bainer
Jack A. Baird
Robert A. Baker, Sr.
William F. Ballhaus
Harvey O. Banks
John Bardeen
Edward J. Barlow
Howard C. Barnes
Harry F. Barr
Thomas D. Barrow
Jordan J. Baruch
Richard H. Battin
Benjamin B. Bauer
Robert F. Bauer
Samuel S. Baxter
Arnold O. Beckman
Lynn S. Beedle
Milo C. Bell
Bernard P. Bellport
Manson Benedict
Leo L. Beranek
William B. Bergen
Donald S. Berry
Maurice A. Biot
R. Byron Bird
Raymond L. Bisplinghoff
Donald L. Bitzer
Benjamin P. Blasingame
John A. Blume
Hendrik W. Bode*
Ray H. Boundy
Sidney A. Bowhill
Robert A. Bowman
James Boyd
Willard S. Boyle
Lewis M. Branscomb
Robert Bromberg
Harvey Brooks
Norman H. Brooks
Burton P. Brown
George H. Brown
Gordon S. Brown
Harold Brown
Milton Brumer
Arthur E. Bryson, Jr.
Solomon J. Buchsbaum
J. Fred Bucy, Jr.
Arthur M. Bueche
D. C. Burnham
Stanley W. Burriss
Adolf Busemann
Spencer H. Bush
Henri Busignies
Robert W. Cairns
Joseph M. Caldwell
Robert H. Cannon, Jr.
John D. Caplan
Roy W. Carlson
George F. Carrier
Arthur Casagrande
Leo Casagrande
William F. Cassidy, USA (Ret.)
Jack E. Cermak
Wallace L. Chadwick
Carl C. Chambers
Joseph V. Charyk
Paul F. Chenea
Harry E. Chesebrough
Harold Chestnut
Marvin Chodorow
Ven Te Chow

---

*Founding Member

Stuart W. Churchill
Walker L. Cisler*
Frederick J. Clarke, USA (Ret.)
Francis H. Clauser
Edward J. Cleary
Ray W. Clough
Karl P. Cohen
Morris Cohen
Nathan Cohn
Edward N. Cole
Arthur A. Collins
Edgar M. Cortright
John P. Craven
Ralph E. Cross
Floyd L. Culler, Jr.
A. Earl Cullum, Jr.
Malcolm R. Currie
C. Chapin Cutler
George C. Dacey
Lee L. Davenport
Edward E. David, Jr.
Frank W. Davis
Harmer E. Davis
W. Kenneth Davis
Don U. Deere
Richard D. DeLauer
John H. Dessauer
Alton C. Dickieson
Allen F. Donovan
Donald W. Douglas
Walter S. Douglas
Jacob H. Douma
Robert M. Drake, Jr.
Charles S. Draper
Mildred S. Dresselhaus
Daniel C. Drucker
Ernst R.G. Eckert
J. Presper Eckert
Harold E. Edgerton
Alfred J. Eggers, Jr.
Phillip Eisenberg
Rolf Eliassen
Charles H. Elmendorf III
James C. Elms
Charles W. Elston
Howard W. Emmons
Elmer W. Engstrom*
Bob O. Evans
James L. Everett, III
William L. Everitt*
Maxime A. Faget
James R. Fair, Jr.
Robert M. Fano
Jean Howard Felker
Michael Ference, Jr.
Phil M. Ferguson
Antonio Ferri
Karl L. Fetters
A. J. Field
Lester M. Field
Morris E. Fine
Daniel J. Fink
Donald G. Fink
Harold W. Fisher
James B. Fisk
Peter T. Flawn
Alexander H. Flax
James C. Fletcher
Richard G. Folsom
Mars G. Fontana
Jay W. Forrester
John S. Foster, Jr.
Donald N. Frey
Robert A. Frosch
John C. Frye
Eugene G. Fubini
E. Montford Fucik
Elmer L. Gaden, Jr.
Albert P. Gagnebin
Antoine M. Gaudin*
Joseph G. Gavin, Jr.
Ben C. Gerwick, Jr.
Ivan A. Getting
John C. Geyer
James F. Gibbons
Richard P. Gifford
Robert R. Gilruth
Charles P. Ginsburg
Edward L. Ginzton
T. Keith Glennan
Earnest F. Gloyna
Martin Goland
Peter C. Goldmark
Edward J. Gornowski
Harold B. Gotaas
Roy W. Gould
William R. Gould
Richard J. Grosh
Robert C. Gunness
Jerrier A. Haddad
Vladimir Haensel
Lawrence R. Hafstad

---

* Founding Member

Patrick E. Haggerty
Michael L. Haider*
James M. Hait
Albert C. Hall
William J. Hall
Kenneth W. Hamming
John C. Hancock
Paul D. Haney
N. Bruce Hannay
Thomas J. Hanratty
Donald R.F. Harleman
John D. Harper
George A. Hawkins
Willis M. Hawkins
Richard Hazen
Henry T. Heald
Alfred Hedefine
Ira G. Hedrick
Hubert Heffner
Edward H. Heinemann
S. W. Herwald
William R. Hewlett
Walter R. Hibbard, Jr.
James Hillier
John P. Hirth
Claude R. Hocott
Nicholas J. Hoff
Eivind Hognestad
George E. Holbrook*
Mark D. Hollis
Solomon C. Hollister
J. Herbert Hollomon*
Frederic A. L. Holloway
Marshall G. Holloway
Nick Holonyak, Jr.
Grace M. Hopper, USNR
Hoyt C. Hottel
Olaf A. Hougen
George W. Housner
Donald E. Hudson
William H. Huggins
Arthur E. Humphrey
Jerome C. Hunsaker#
J. Donovan Jacobs
John E. Jacobs
Robert I. Jaffee
Stephen M. Jenks#
Clarence L. Johnson
H. Richard Johnson
James R. Johnson
Wendell E. Johnson
Wilfrid E. Johnson
Woodrow E. Johnson
Robert T. Jones
Thomas F. Jones
J. Erik Jonsson
Edward C. Jordan
Charles H. Kaman
Donald L. Katz
Thomas C. Kavanagh*
Alfred A.H. Keil
Percival C. Keith
Clarence F. Kelly
John F. Kennedy
George W. Kessler
Raymond W. Ketchledge
Fazlur R. Khan
John R. Kiely
Jack S. Kilby
James R. Killian, Jr.
Augustus B. Kinzel*
Chalmer G. Kirkbride
Hugh S. Knowles
Rudolf Kompfner
Christopher C. Kraft, Jr.
John D. Kraus
T. William Lambe
Edwin H. Land
Ralph Landau
James N. Landis*#
Helmut E. Landsberg
Clarence E. Larson
Allen Latham, Jr.
Joseph C. Lawler
Stephen Lawroski
Jerome F. Lederer#
Lester Lees
Frank W. Lehan
Thomas M. Leps
Humboldt W. Leverenz
Salomon Levy
David S. Lewis, Jr.
W. Deming Lewis
Warren K. Lewis#
Hans W. Liepmann
T.Y. Lin
Henry R. Linden
Clarence H. Linder*
Frederick C. Lindvall
Donald P. Ling

---

* Founding Member
\# Member Emeritus

NAE Membership

Edwin A. Link
John G. Linvill
C. Gordon Little
Robert G. Loewy
John A. Logan
Bernard D. Loughlin
Alan M. Lovelace
George M. Low
John Lowe, III
Harvey F. Ludwig
John H. Ludwig
Benjamin Lustman
J. Ross Macdonald
W. D. MacDonnell
Douglas C. MacMillan
Theodore H. Maiman
Plato Malozemoff
William D. Manly
Robert W. Mann
Frank E. Marble
W. Robert Marshall
Thomas L. Martin, Jr.
Fujio Matsuda
Hans A. Mauch
John W. Mauchly
Jerry McAfee
Gerald T. McCarthy
Francis K. McCune
James S. McDonnell
Percy H. McGauhey
Kenneth G. McKay
Jack E. McKee
John E. McKeen
John J. McKetta, Jr.
William B. McLean
John L. McLucas
Robert C. McMaster
Brockway McMillan
George F. Mechlin
Ruben F. Mettler
Dwight F. Metzler
Otto N. Miller
Rene H. Miller
Stewart E. Miller
Raymond D. Mindlin
John L. Moll
Alexander Monteith
George E. Mueller
James H. Mulligan, Jr.
Eugene F. Murphy

Dale D. Myers
Phillip S. Myers
Theodore J. Nagel
Gerhard Neumann
Joseph H. Newman
Nathan M. Newmark*
Kenneth D. Nichols, USA (Ret.)
Daniel E. Noble
Robert N. Noyce
Morrough P. O'Brien
David Okrent
Daniel A. Okun
Bruce S. Old
Bernard M. Oliver
Elburt F. Osborn
David Packard
Hilliard W. Paige
Thomas O. Paine
Nunzio J. Palladino
Earl R. Parker
Robert J. Parks
Alfred L. Parme
Gerald L. Pearson
Ralph B. Peck
Donald O. Pederson
William S. Pellini
Maynard L. Pennell
Courtland D. Perkins
Kendall Perkins
William J. Perry
Max S. Peters
Allen M. Peterson
Dean F. Peterson
Joseph M. Pettit
Samuel C. Phillips, USAF
Thomas L. Phillips
William H. Pickering*
John R. Pierce
Robert L. Pigford
Milton Pikarsky
Emanuel R. Piore
Robert Plunkett
David S. Potter
William Prager#
Perry W. Pratt
Allen E. Puckett
Calvin F. Quate
Louis T. Rader
Jan A. Rajchman
Simon Ramo*

---

* Founding Member
# Member Emeritus

William B.W. Rand
Arthur E. Raymond*#
Eberhardt Rechtin
Charles E. Reed
Eugene D. Reed
Eberhard F.M. Rees
Robert B. Richards
Frank E. Richart, Jr.
H. G. Rickover, USN#
Denis M. Robinson
Louis H. Roddis, Jr.
Gerard A. Rohlich
L. Eugene Root
Harold A. Rosen
Joe B. Rosenbaum
Paul Rosenberg
Walter A. Rosenblith
Ian M. Ross
Philip N. Ross
Hunter Rouse
Will H. Rowand
Rustum Roy
Robert W. Rummel
Philip C. Rutledge
Henry A. Schade
George S. Schairer
Bernard A. Schriever, USAF (Ret.)
Karl Schwartzwalder
Ronald F. Scott
Robert C. Seamans, Jr.
William R. Sears
H. Bolton Seed
Fred N. Severud
Ascher H. Shapiro
Milton C. Shaw
Joseph F. Shea
Timothy E. Shea
Herman E. Sheets
Mark Shepherd, Jr.
William G. Shepherd
Thomas K. Sherwood*
William E. Shoupp
Anthony E. Siegman
Chester P. Siess
Samuel Silver
Abe Silverstein
John W. Simpson
Donald B. Sinclair
Sigurd A. Sjoberg
John B. Skilling
Cedomir M. Sliepcevich
Ronald Smelt
Levering Smith, USN
Mark K. Smith
Wilbur S. Smith
Louis D. Smullin
C. Richard Soderberg
George E. Solomon
Mott Souders
Monroe E. Spaght
Morgan Sparks
William J. Sparks
Philip Sporn
Lombard Squires
Alfred D. Starbird, USA (Ret.)
Chauncey Starr
H. Guyford Stever
Julius A. Stratton*
C. Guy Suits*
Verner E. Suomi
Ivan E. Sutherland
John E. Swearingen
Morris Tanenbaum
Richard H. Tatlow III
John J. Taylor
Gordon K. Teal
Anton Tedesko
Michael Tenenbaum
Frederick E. Terman*
Charles A. Thomas*#
John A. Tillinghast
Frederick H. Todd#
Myron Tribus
John G. Truxal
Howard S. Turner
M. E. Van Valkenburg
Oswald G. Villard, Jr.
Wernher von Braun
Aubrey J. Wagner
Harvey A. Wagner
Eric A. Walker*
Dean A. Watkins
Arthur H. Waynick
Ernst Weber*
Edward C. Wells
Edward Wenk, Jr.
G. O. Wessenauer
James W. Westwater
Elmer P. Wheaton
Albert D. Wheelon
John R. Whinnery
Robert M. White

---

* Founding Member
\# Member Emeritus

Jerome B. Wiesner
Lyman D. Wilbur
Stanley D. Wilson
Thornton A. Wilson
George Winter
Abel Wolman#
Carlos C. Wood
James F. Young
Lotfi A. Zadeh
Walter H. Zinn
Vladimir K. Zworykin

MEMBERS DECEASED

Othmar H. Ammann
Thomas H. Chilton
Hugh L. Dryden*
Gordon M. Fair
Merrell R. Fenske
Clifford C. Furnas
William F. Gibbs
Lillian M. Gilbreth
Edwin R. Gilliland
Arthur T. Ippen
John M. Kyle, Jr.
William C. Mentzer
Clark B. Millikan*
Julius P. Molnar
Jack A. Morton
Carl F. Prutton
Igor I. Sikorsky
Walter G. Whitman
Richard H. Wilhelm

---

*Founding Member

APPENDIX II

OFFICERS AND COUNCILLORS
of the
National Academy of Engineering
(December, 1964 - December, 1974)

OFFICERS

The officers of the Academy shall be a president and a vice president, who shall be members of the Council, and such other officers, including a secretary and a treasurer...as the Council from time to time may determine.
(Bylaws, Article VI, Section 1)

1964 - 1965[1]

A. B. Kinzel, Pres.
E. A. Walker, V. Pres.
T. C. Kavanagh, Treas.
H. K. Work, Sec.

1965 - 1966

A. B. Kinzel, Pres.
E. A. Walker, V. Pres.
T. C. Kavanagh, Treas.
H. K. Work, Sec.

1966 - 1967

E. A. Walker, Pres.
C. H. Linder, V. Pres.
T. C. Kavanagh, Treas.
H. K. Work, Sec.

1967 - 1968

E. A. Walker, Pres.
C. H. Linder, V. Pres.
T. C. Kavanagh, Treas.
H. K. Work, Sec.

1968 - 1969

E. A. Walker, Pres.
C. H. Linder, V. Pres.
T. C. Kavanagh, Treas.
J. H. Mulligan, Jr., Sec.

1969 - 1970

E. A. Walker, Pres.
C. H. Linder, V. Pres.
T. C. Kavanagh, Treas.
J. H. Mulligan, Jr., Sec.

1970 - 1971

C. H. Linder, Pres.
C. Starr, V. Pres.
T. C. Kavanagh, Treas.
J. H. Mulligan, Jr., Sec.
B. S. Old, For. Sec.

1971 - 1972

C. H. Linder, Pres.
C. Starr, V. Pres.
T. C. Kavanagh, Treas.
J. H. Mulligan, Jr., Sec.
B. S. Old, For. Sec.

1972 - 1973

C. H. Linder, Pres.[2]
C. Starr, V. Pres.
T. C. Kavanagh, Treas.
J. H. Mulligan, Jr., Sec.
B. S. Old, For. Sec.

---

1. Founding officers, elected initially for the period December, 1964 to the close of the second Annual Meeting/spring, 1966. Terms are normally for four years, commencing at the close of the Annual Meeting of the year of election.

2. Resigned, effective close of 1973 Annual Meeting, May 3, 1973.

OFFICERS (Continued)

1973 - 1974	1974 - 1975
R. C. Seamans, Jr., Pres.	R. C. Seamans, Jr. Pres.[3]
C. Starr, V. Pres.	W. E. Shoupp, V. Pres.[4]
T. C. Kavanagh, Treas.	E. N. Cole, Treas.
J. H. Mulligan, Jr., Sec.	J. H. Mulligan, Jr., Sec.
B. S. Old, For. Sec.	B. S. Old, For. Sec.

3. Resigned, effective December 29, 1974.

4. Acting President, December 29, 1974 - April 24, 1975.

COUNCIL AND EXECUTIVE COMMITTEE

Subject to the provisions of the Articles of Organization of the Academy and these bylaws, the Council shall have paramount authority with respect to the funds, activities, policies, and purposes of the Academy.
(Bylaws, Article V, Section 3)

During intervals between meetings of the Council, the Executive Committee may exercise all the powers of the Council except that the Committee may not fill vacancies on the Council or among the officers of the Academy, exercise the powers of the Council with respect to nominations to membership in the Academy, or do any other acts that are expressly prohibited to the Committee by the Council.
(Bylaws, Article V, Section 5)

64

1964 - 1965	1965 - 1966	1966 - 1967
*A. B. Kinzel, Pres.	*A. B. Kinzel, Pres.	*E. A. Walker, Pres.
*E. A. Walker, V. Pres.	*E. A. Walker, V. Pres.	*C. H. Linder, V. Pres.
*T. C. Kavanagh, Treas.	*T. C. Kavanagh, Treas.	*T. C. Kavanagh, Treas.
*F. Seitz, NAS Pres.[1]**	*F. Seitz, NAS Pres.	A. B. Kinzel, Past Pres.
W. L. Cisler	W. L. Cisler	*F. Seitz, NAS Pres.
E. W. Engstrom	E. W. Engstrom	W. L. Cisler
A. M. Gaudin	A. M. Gaudin	E. W. Engstrom
M. L. Haider	M. L. Haider	A. M. Gaudin
G. E. Holbrook	G. E. Holbrook	M. L. Haider
J. H. Hollomon	J. H. Hollomon	*G. E. Holbrook
*C. H. Linder	*C. H. Linder	J. H. Hollomon
N. M. Newmark	N. M. Newmark	*N. M. Newmark
*J. A. Stratton	*J. A. Stratton	J. A. Stratton
C. A. Thomas	C. A. Thomas	C. A. Thomas
E. Weber	E. Weber	*E. Weber

* Member of the Executive Committee of the Council.
** Superscripts refer to explanatory notes, Page 67.

COUNCIL AND EXECUTIVE COMMITTEE (Continued)

1967 - 1968

*E. A. Walker, Pres.
*C. H. Linder, V. Pres.
*T. C. Kavanagh, Treas.
*F. Seitz, NAS Pres.
W. L. Cisler
E. W. Engstrom
E. G. Fubini
A. M. Gaudin
M. L. Haider
*G. E. Holbrook
J. H. Hollomon
*N. M. Newmark
*J. R. Pierce
S. Ramo
J. A. Stratton

1968 - 1969

*E. A. Walker, Pres.
*C. H. Linder, V. Pres.
*T. C. Kavanagh, Treas.
*F. Seitz, NAS Pres.
*H. G. Busignies
*W. L. Cisler
E. W. Engstrom
E. G. Fubini
A. M. Gaudin
M. L. Haider
*W. R. Hibbard, Jr.
*J. R. Pierce
S. Ramo
L. E. Root
C. Starr
J. A. Stratton

1969 - 1970

*E. A. Walker, Pres.
*C. H. Linder, V. Pres.
*T. C. Kavanagh, Treas.
*P. Handler, NAS Pres.
G. S. Brown
*H. G. Busignies
*E. G. Fubini
T. K. Glennan[2]**
M. Goland
P. E. Haggerty
W. R. Hibbard, Jr.
S. Ramo
L. E. Root[3]
C. Starr
*H. G. Stever
J. A. Stratton

65

1970 - 1971

*C. H. Linder, Pres.
*C. Starr, V. Pres.
*T. C. Kavanagh, Treas.
*E. A. Walker, Past Pres.
*P. Handler, NAS Pres.
L. L. Beranek
G. S. Brown
*H. G. Busignies
*R. W. Cairns
E. E. David, Jr.[4]
J. H. Dessauer
E. G. Fubini
T. K. Glennan[5]
M. Goland
P. E. Haggerty[6]

1970 - 1971 (Continued)

W. R. Hibbard, Jr.
H. G. Stever,
E. Wenk, Jr.[7]

1971 - 1972

*C. H. Linder, Pres.
*C. Starr, V. Pres.
*T. C. Kavanagh, Treas.
*P. Handler, NAS Pres.
R. L. Bisplinghoff
G. S. Brown
*R. W. Cairns
F. H. Clauser
*J. H. Dessauer
*E. G. Fubini
M. Goland
J. Hillier
*F. A. L. Holloway[8]
J. R. Macdonald
K. G. McKay
H. G. Stever

80

81

* Member of the Executive Committee of the Council.
** Superscripts refer to explanatory notes, page 67.

COUNCIL AND EXECUTIVE COMMITTEE (Continued)

1972 - 1973

*C. H. Linder, Pres.[9]**
*C. Starr, V. Pres.
*T. C. Kavanagh, Treas.
*P. Handler, NAS Pres.
W. C. Ackermann
R. L. Bisplinghoff[10]
*R. W. Cairns
P. F. Chenea
F. H. Clauser
W. K. Davis
*J. H. Dessauer
D. N. Frey[11]
*E. G. Fubini
*F. A. L. Holloway
W. D. Lewis
J. R. Macdonald
K. G. McKay

1973 - 1974

*R. C. Seamans, Jr., Pres.
*C. Starr, V. Pres.
*T. C. Kavanagh, Treas.
*C. H. Linder, Past Pres.
*P. Handler, NAS Pres.
W. C. Ackermann
R. W. Cairns
P. F. Chenea
*W. K. Davis
*J. H. Dessauer
D. N. Frey
*F. A. L. Holloway
R. Landau
*W. D. Lewis
J. R. Macdonald
K. G. McKay
J. M. Pettit

1974 - 1975

*R. C. Seamans, Jr., Pres.[12]
*W. E. Stoupp, V. Pres.[13]
*E. N. Cole, Treas.
*P. Handler, NAS Pres.
W. C. Ackermann
*A. E. Bryson, Jr.
P. F. Chenea
*W. K. Davis
J. H. Dessauer
E. L. Ginzton
R. C. Gunness
*F. A. L. Holloway
R. Landau
*W. D. Lewis
J. M. Pettit
M. Tanenbaum

99

* Member of the Executive Committee of the Council.
** Superscripts, refer to explanatory notes, p. 67.

COUNCIL AND EXECUTIVE COMMITTEE (Continued)

Explanatory Notes:

1. The NAS President serves ex officio.
2. Glennan: elected by Council October 9, 1969 to fill the vacancy created by resignation of L. E. Root.
3. Root: resigned effective May 19, 1969.
4. David: resigned effective October 15, 1970.
5. Glennan: resigned effective October 15, 1970.
6. Haggerty: resigned effective January 13, 1971.
7. Wenk: elected by Council October 15, 1970 to fill the vacancy created by resignation of E. E. David, Jr.
8. Holloway: elected to fill unexpired term of T. K. Glennan, effective close of 1971 Annual Meeting, April 27, 1971.
9. Linder: resigned, effective close of 1973 Annual Meeting, May 3, 1973.
10. Bisplinghoff: resigned effective May 18, 1972.
11. Frey: elected by Council September 6, 1972 to fill the vacancy created by resignation of R. L. Bisplinghoff.
12. Seamans: resigned, effective December 29, 1974.
13. Shoupp: Acting President, December 30, 1974 - April 24, 1975. C. D. Perkins was subsequently elected President effective April 24, 1975 to fill the unexpired term of R. C. Seamans, Jr., through close of Annual Meeting, 1978.

67

APPENDIX III

STANDING ADMINISTRATIVE COMMITTEES of the National Academy of Engineering (December 1964 - December 1974)

AUDITING COMMITTEE
(Established December 10, 1964)

The Committee shall arrange for an audit, by independent certified public accountants, of the accounts of the Academy for the current fiscal year and shall present the report of audit to the Academy at the next annual meeting, together with such comments and recommendations as the Committee may deem appropriate. The Committee may cause to be made any other examinations of the financial records, the accounting records, and the system of internal control of the Academy that, in its judgment, are necessary for the determination of the adequacy and accuracy of the accounts of the Academy.

(Bylaws, Article VII, Section 2)

69

1964 - 1965

M. L. Haider, Chmn.
A. M. Gaudin
A. E. Raymond

1965 - 1966

M. L. Haider, Chmn.
A. M. Gaudin
A. E. Raymond

1966 - 1967

A. M. Gaudin, Chmn.
J. E. McKeen
A. E. Raymond

1967 - 1968

H. Rouse, Chmn.
A. M. Gaudin
L. H. Roddis, Jr.

1968 - 1969

G. A. Hawkins, Chmn.
M. R. Fenske
R. H. Tatlow III

1969 - 1970

G. A. Hawkins, Chmn.
M. R. Fenske
R. H. Tatlow III

1970 - 1971

A. H. Waynick, Chmn.
L. Smith
L. Squires

1971 - 1972

M. D. Hollis, Chmn.
W(endell) E. Johnson
E. F. Osborn

1972 - 1973

C. G. Kirkbride, Chmn.
J. C. Geyer
J. L. McLucas

1973 - 1974

T. O. Paine, Chmn.
C. G. Kirkbride
W. G. Shepherd

1974 - 1975

K. L. Fetters, Chmn.
H. F. Barr
T. O. Paine

AWARDS COMMITTEE
(Established by the Council, April 29, 1965)

To formulate general policies regarding awards and honors administered by the National Academy of Engineering, and submit such policies and specific recommendations for approval by the Council; to formulate a general program designed to meet the needs and desires of the Academy in the matter of awards and honors, and implement the establishment of new awards and honors, as may be approved by the Council; to select, subject to approval by the Council, the recipients of the existing awards and honors; to make plans for a Founders Lecture to be held annually or from time to time at the National Academy of Engineering by an individual known for his outstanding contributions to engineering; to make recommendations to the Council as to policies and procedures to be followed in implementing such plans.

1965 - 1966

W. L. Chadwick, Chmn.
E. L. Ginzton

1966 - 1967

W. L. Chadwick, Chmn.
E. L. Ginzton

1967 - 1968

W. L. Chadwick, Chmn.
G. W. Housner
R. Kompfner

1968 - 1969

R. Kompfner, Chmn.
G. W. Housner
W. H. Pickering
E. R. Piore
J. F. Young

1969 - 1970

R. Kompfner, Chmn.
G. W. Housner
W. H. Pickering
E. R. Piore
J. F. Young

1970 - 1971

R. Kompfner, Chmn.
D. G. Fink
W. H. Pickering
E. R. Piore
R. M. White

1971 - 1972

R. J. Grosh, Chmn.
P. F. Chenea
D. G. Fink
G. M. Low
J. J. McKetta, Jr.
C. Guy Suits
J. G. Truxal
R. M. White

1972 - 1973

R. J. Grosh, Chmn.
P. F. Chenea
M. Goland
G. M. Low
T. L. Martin, Jr.
J. J. McKetta, Jr.
C. Guy Suits
J. G. Truxal

1973 - 1974

R. J. Grosh, Chmn.
L. S. Beedle
P. F. Chenea
G. M. Low
T. L. Martin, Jr.
J. J. McKetta, Jr.
C. Guy Suits

1974 - 1975

G. M. Low, Chmn.
L. S. Beedle
C. C. Cutler
G. M. Hopper
J. R. Johnson
H. E. Landsberg
M. S. Peters

BIOGRAPHICAL MEMOIRS COMMITTEE
(Established by the Council October 20, 1965)

To prepare in an appropriate fashion Biographical Memoirs for the National Academy of Engineering.

1965 - 1966

A. M. Gaudin, Chmn.
F. H. Todd

1966 - 1967

A. M. Gaudin, Chmn.
F. H. Todd

1967 - 1968

A. M. Gaudin, Chmn.
F. H. Todd

1968 - 1969

L. Squires, Chmn.
C. H. Kaman

1969 - 1970

L. Squires, Chmn.
W(oodrow) E. Johnson

1970 - 1971

L. Squires, Chmn.
W(oodrow) E. Johnson

71

1971 - 1972

L. Squires, Chmn.
A. M. Gaudin

1972 - 1973

L. Squires,

1973 - 1974

L. Squires, Chmn.

1974 - 1975

E. H. Heinemann, Chmn.

AD HOC DEVELOPMENT COMMITTEE*
(Established by the Council April 29, 1965)

To seek to increase the income of the National Academy of Engineering by means of obtaining gifts, grants, and endowments for the Academy, both immediately and thereafter.

1965 - 1966

J. N. Landis, Chmn.[1]**
W. L. Cisler
M. L. Haider
C. A. Thomas

1966 - 1967

P. Sporn, Chmn.[2]
W. L. Cisler
P. E. Haggerty
M. L. Haider
J. E. McKeen
A. C. Monteith
C. A. Thomas

1967 - 1968

P. Sporn, Chmn.
W. L. Cisler
P. E. Haggerty
M. L. Haider
J. E. McKeen
A. C. Monteith
C. A. Thomas
T. C. Kavanagh[3]

1968 - 1969

P. Sporn, Chmn.
W. L. Cisler
P. E. Haggerty
M. L. Haider[4]
T. C. Kavanagh[3]
J. E. McKeen
A. C. Monteith

1969 - 1970

P. Sporn, Chmn.
D. C. Burnham
R. W. Cairns
W. L. Cisler
R. C. Gunness
D. E. Noble
P. E. Haggerty[5]

1970 - 1971

P. Sporn, Chmn.[6]
D. C. Burnham
R. W. Cairns
W. L. Cisler
R. C. Gunness
D. E. Noble

1971 - 1972

J. H. Dessauer[7]
D. C. Burnham
R. W. Cairns
W. L. Cisler
R. C. Gunness
D. E. Noble

1972 - 1973[8]

1973 - 1974

D. N. Frey, Chmn.[9]

1974 - 1975

D. N. Frey, Chmn.
E. L. Ginzton
J. D. Harper
J. E. Jonsson
J. R. Kiely
D. Packard

* Formerly Committee on Gifts and Endowments.
** Superscripts refer to explanatory notes, page 73.

AD HOC DEVELOPMENT COMMITTEE (Continued)

Explanatory Notes:

1. Landis: resigned March 2, 1966.
2. Sporn: appointment as Chairman announced at Council Meeting of March 27, 1967.
3. Kavanagh: ex officio, Treasurer of the NAE.
4. Haider: resigned May, 1969.
5. Haggerty: resigned November, 1969.
6. Sporn: resigned January 22, 1971.
7. Dessauer: appointed chairman of an ad hoc Committee of Council members on Gifts and Endowments (minutes of the Council, September 10, 1971).
8. Action regarding the appointment of the Gifts and Endowments Committee deferred pending completion of a study on the needs of the Academy (minutes of the Council, April 22, 1972).
9. Frey: appointment announced at the meeting of the Council on November 16, 1973, and the committee identified as the ad hoc Development Committee.

73

FINANCE COMMITTEE
(Established December 10, 1964)

The Committee shall prepare and present to the Council the annual general budget of the Academy and shall determine matters relating to the purchase and sale of securities or other investments that are under the administration or control of the Academy. The Committee shall have the power, subject to the approval of the Council, to employ competent investment counsel to advise the Committee.
(Bylaws, excerpt from Article VII, Section 1)

1964 - 1965	1965 - 1966	1966 - 1967
*T. C. Kavanagh, Chmn.	T. C. Kavanagh, Chmn.	T. C. Kavanagh, Chmn.
*F. Seitz, NAS Pres.	F. Seitz, NAS Pres.	F. Seitz, NAS Pres.
W. L. Cisler	W. L. Cisler	W. L. Cisler
M. L. Haider	M. L. Haider	M. L. Haider
G. E. Holbrook	G. E. Holbrook	G. E. Holbrook
S. Ramo	S. Ramo	S. Ramo
C. G. Suits	C. G. Suits	C. G. Suits
C. A. Thomas	C. A. Thomas	C. A. Thomas
1967 - 1968	**1968 - 1969**	**1969 - 1970**
T. C. Kavanagh, Chmn.	T. C. Kavanagh, Chmn.	T. C. Kavanagh, Chmn.
F. Seitz, NAS Pres.	F. Seitz, NAS Pres.	P. Handler, NAS Pres.
J. B. Austin	J. B. Austin	A. O. Beckman
J. Hillier	J. Hillier	G. H. Brown
F. K. McCune	F. K. McCune	J. H. Dessauer
L. H. Roddis, Jr.	L. H. Roddis, Jr.	H. T. Heald
C. G. Suits	C. G. Suits	

74

97

98

* Ex officio. In accordance with the Bylaws (Article VII, Section 1), the NAE Treasurer serves as chairman of the Committee, and the NAS President as a member.

FINANCE COMMITTEE (Continued)

1970 - 1971

T. C. Kavanagh, Chmn.
P. Handler, NAS Pres.
J. H. Dessauer
L. H. Roddis, Jr.
M. Shepherd, Jr.

1971 - 1972

T. C. Kavanagh, Chmn.
P. Handler, NAS Pres.
J. H. Dessauer
F. A. L. Holloway
L. H. Roddis, Jr.
M. Shepherd, Jr.

1972 - 1973

T. C. Kavanagh, Chmn.
P. Handler, NAS Pres.
N. Cohn
A. E. Cullum, Jr.
W. K. Davis
J. H. Dessauer

1973 - 1974

T. C. Kavanagh, Chmn.
P. Handler, NAS Pres.
E. N. Cole
R. G. Folsom
T. F. Jones
H. W. Paige
M. Shepherd, Jr.
H. S. Turner

1974 - 1975

E. N. Cole, Chmn.
P. Handler, NAS Pres.
R. G. Folsom
T. F. Jones
T. C. Kavanagh
H. W. Paige
M. Shepherd, Jr.
H. S. Turner

75

NAS/NAE JOINT BOARD
NAE Membership
(Established December 5, 1964)*

The Council of the National Academy of Engineering and the Council of the National Academy of Sciences shall each select an equal number of persons to serve as a Joint Board to recommend policies and modes of operation for accomplishing the most effective cooperation between the two Academies and to perform such other functions as may be assigned to it by joint action of the Councils of the two Academies.
(Articles of Organization, Article VIII, Section 1)

1965 - 1966

G. E. Holbrook
N. M. Newmark
E. A. Walker

1966 - 1967

G. E. Holbrook
N. M. Newmark
H. G. Stever

1967 - 1968

C. H. Linder
N. M. Newmark
H. G. Stever

1968 - 1969

C. H. Linder
N. M. Newmark
H. G. Stever

1969 - 1970

C. H. Linder
N. M. Newmark
H. G. Stever

1970 - 1971

N. M. Newmark
C. Starr
H. G. Stever

1971 - 1972

J. H. Dessauer
C. Starr
H. G. Stever

1972 - 1973

J. H. Dessauer
J. R. Macdonald
C. Starr

1973 - 1974

R. W. Cairns
J. H. Dessauer
J. R. Macdonald

1974 - 1975

R. W. Cairns
J. H. Dessauer
J. R. Macdonald

* Committee members first appointed March 17, 1965.

COMMITTEE ON MEMBERSHIP
(Established December 10, 1964)

The functions of the Committee shall be to analyze the membership structures of the Academy, to originate nominations, and to appraise nominations received from the members.
(Bylaws, excerpt from Article VII, Section 3)

1964 - 1965	1965 - 1966	1966 - 1967
C. H. Linder, Chmn.	C. H. Linder, Chmn.	C. H. Linder, Chmn.
H. W. Bode	H. W. Bode	H. F. Barr
W. L. Cisler	W. L. Chadwick	W. L. Chadwick
H. L. Dryden	W. L. Cisler	E. W. Engstrom
E. W. Engstrom	H. L. Dryden[1]*	W. L. Everitt
W. L. Everitt	E. W. Engstrom	K. L. Fetters
J. H. Hollomon	W. L. Everitt	R. G. Folsom
J. N. Landis	R. G. Folsom[2]	P. E. Haggerty
C. B. Millikan	P. E. Haggerty	E. H. Heinemann
S. Ramo	J. H. Hollomon	G. E. Holbrook[3]
T. K. Sherwood	J. N. Landis	J. H. Hollomon
F. E. Terman	C. B. Millikan	J. N. Landis
	S. Ramo	C. B. Millikan[4]
	T. K. Sherwood	S. Ramo
	J. B. Skilling	J. W. Simpson
	H. G. Stever	J. B. Skilling
	F. E. Terman	H. G. Stever

* Superscripts refer to explanatory notes, Page 80.

1967 - 1968

C. H. Linder, Chmn.
H. F. Barr
L. L. Beranek
W. L. Chadwick
E. W. Engstrom
K. L. Fetters
R. G. Folsom
E. H. Heinemann
J. H. Hollomon
J. N. Landis
B. D. Loughlin
W. R. Marshall
T. E. Shea
J. W. Simpson
J. B. Skilling
H. G. Stever

1968 - 1969

W. R. Hibbard, Jr., Chmn.
H. F. Barr
L. L. Beranek
K. L. Fetters
R. G. Folsom
E. H. Heinemann
G. E. Holbrook
M. D. Hollis
C. H. Linder
B. D. Loughlin
W. R. Marshall
T. E. Shea
C. P. Siess
J. W. Simpson
M. K. Smith
H. G. Stever
L. D. Wilbur

1969 - 1970

W. R. Hibbard, Jr., Chmn.
L. L. Beranek
R. G. Folsom
G. E. Holbrook
M. D. Hollis
G. W. Kessler
A. B. Kinzel
C. H. Linder
B. D. Loughlin
W. R. Marshall
J. E. McKee
J. A. Morton
E. F. Murphy
M. S. Peters
T. E. Shea
C. P. Siess
M. K. Smith
W. S. Smith
G. E. Solomon
H. G. Stever
V. E. Suomi
L. D. Wilbur
J. F. Young

78

COMMITTEE ON MEMBERSHIP (Continued)

1970 - 1971	1971 - 1972	1972 - 1973
E. E. David, Jr., Chmn.	E. E. David, Jr., Chmn.	H. E. Davis, Chmn.
L. M. Field	V. W. Bacon	V. W. Bacon
A. H. Flax	N. Cohn	G. S. Brown
R. G. Folsom	H. E. Davis	N. Cohn
G. E. Holbrook	M. Ference, Jr.	M. Ference, Jr.
M. D. Hollis	L. M. Field	L. M. Field
J. H. Hollomon	A. H. Flax	A. H. Flax
G. W. Kessler	R. G. Folsom	R. G. Folsom
J. E. McKee	J. H. Hollomon	I. A. Getting
J. A. Morton	G. W. Kessler	J. H. Hollomon
E. F. Murphy	J. R. Kiely[5*]	W(ilfred) E. Johnson
H. W. Paige	J. E. McKee	J. R. Kiely
M. S. Peters	J. A. Morton	J. E. McKee
H. Rouse	E. F. Murphy	E. F. Murphy
C. P. Siess	H. W. Paige	P. N. Ross
L. Smith	M. S. Peters	H. Rouse
M. K. Smith	H. Rouse	A. Tedesko
G. E. Solomon	L. Smith	E. C. Wells
H. G. Stever	W. S. Smith	G. Winter
V. E. Suomi	G. E. Solomon	J. F. Young
L. D. Wilbur	V. E. Suomi	
J. F. Young	A. Tedesko	
	G. Winter	
	J. F. Young	

79

* Superscript refers to explanatory notes, Page 80.

COMMITTEE ON MEMBERSHIP (Continued)

1973 - 1974

M. Goland, Chmn.
J. R. Kiely, V. Chmn.[6]
V. W. Bacon
E. J. Barlow[7]
R. L. Bisplinghoff[8]
J. Boyd[7]
G. S. Brown
N. Conn
D. C. Drucker[7]
A. J. Eggers, Jr.[7]
M. Ference, Jr.
R. G. Folsom
I. A. Getting
W(ilfred) E. Johnson

1973 - 1974 (Continued)

J. A. Logan
J. E. McKee
J. J. McKetta, Jr.
G. E. Mueller
E. F. Murphy
P. N. Ross
T. K. Sherwood[7]
W. E. Shoupp[7]
J. W. Simpson[7]
M. Tanenbaum
A. Tedesko
E. C. Wells
G. Winter
J. F. Young

1974 - 1975

M. Goland, Chmn.
J. R. Kiely, V. Chmn.
A. L. Babb
D. C. Drucker
M. E. Fine
R. G. Folsom
I. A. Getting
W(ilfred) E. Johnson
C. G. Kirkbride
J. E. McKee
J. J. McKetta, Jr.
G. E. Mueller
E. F. Murphy
P. N. Ross
M. C. Shaw
M. Tanenbaum
E. C. Wells
J. F. Young

80

Explanatory Notes:

1. Dryden: deceased December 2, 1965.

2. Folsom: appointed to fill unexpired term of Dryden.

3. Holbrook: appointed to fill unexpired term of C. B. Millikan.

4. Millikan: deceased January, 1966.

5. Kiely: appointed Chairman, Search Subcommittee, April 28, 1972, with R. G. Folsom, W. D. Lewis, J. J. McKetta, Jr., E. F. Murphy, R. Smelt as members.

6. Kiely: appointed Vice Chairman of the Committee September 17, 1973, by Council action.

7. Ex officio, Chairmen, Peer Groups of the Committee on Membership. Appointed to membership on the Committee September 17, 1973, by Council action.

8. Bisplinghoff: Peer Group Coordinator.

NOMINATING COMMITTEE
(Established December 10, 1964)

To prepare nominations to fill any vacancies that will occur in that year in the Council or among the officers of the Academy.
(Bylaws, excerpt from Article VII, Section 4)

1964 - 1965

E. W. Engstrom, Chmn.
G. E. Holbrook
W. H. Pickering
C. H. Linder
E. Weber

1965 - 1966

E. W. Engstrom, Chmn.
G. E. Holbrook
W. H. Pickering
C. H. Linder
E. Weber

1966 - 1967

W. L. Everitt, Chmn.
G. E. Holbrook
J. N. Landis
N. M. Newmark
C. Starr

1967 - 1968

A. B. Kinzel, Chmn.
C. S. Draper
F. A. L. Holloway
W. D. Lewis
A. C. Monteith

1968 - 1969

F. A. L. Holloway, Chmn.
W. L. Cisler
J. H. Hollomon
J. A. Morton
J. F. Young

1969 - 1970

E. W. Engstrom, Chmn.
H. Brown
E. G. Fubini
F. A. L. Holloway
T. F. Jones

1970 - 1971

J. H. Dessauer, Chmn.*
E. W. Engstrom
J. A. Haddad
E. Rechtin
G. E. Solomon

1971 - 1972

J. R. Killian, Jr., Chmn.
J. H. Dessauer
D. C. Drucker
J. B. Fisk
W. M. Hawkins

1972 - 1973

A. E. Cullum, Jr., Chmn.
P. F. Chenea
M. Goland
S. W. Herwald
J. R. Killian, Jr.

1973 - 1974

E. E. David, Jr., Chmn.
H. Brooks
A. E. Cullum, Jr.
T. K. Glennan
R. Landau

1974 - 1975

T. C. Kavanagh, Chmn.
R. W. Cairns
R. G. Loewy
E. E. David, Jr.
W. D. Lewis

*Replaced P. E. Haggerty who resigned as chairman effective October 15, 1970.

PROJECT COMMITTEE
(Established by the Council September 23, 1965)

The Committee shall recommend the initiation of studies and the organization of symposia and conferences by the Academy, shall review requests for studies and investigations and recommend to the Council suitable action on each, and shall perform such other duties in connection with the programs of the Academy as the Council may direct.
(Bylaws, excerpt from Article VII, Section 5)

1965 - 1966

E. H. Heinemann, Chmn.
H. W. Bode
H. G. Busignies
C. S. Draper
J. H. Hollomon
R. D. Mindlin

1966 - 1967

E. H. Heinemann, Chmn.
D. S. Berry
H. W. Bode
H. G. Busignies
C. S. Draper
K. L. Fetters
J. H. Hollomon
A. A. H. Keil
R. D. Mindlin
J. W. Simpson

1967 - 1968

H. G. Busignies, Chmn.
D. S. Berry
C. S. Draper
K. L. Fetters
E. H. Heinemann
J. H. Hollomon
M. G. Holloway
A. A. H. Keil
R. D. Mindlin
W. Prager
J. W. Simpson

1968 - 1969

H. G. Busignies, Chmn.
M. Chodorow
C. S. Draper
K. L. Fetters
E. R. Gilliland
H. B. Gotaas
M. G. Holloway
J. A. Logan
R. D. Mindlin[1]*
B. S. Old
W. Prager
J. W. Simpson

1969 - 1970

H. G. Busignies, Chmn.
M. Chodorow
E. R. Gilliland
H. B. Gotaas
M. G. Holloway
J. A. Logan
B. S. Old
W. Prager
C. P. Siess
J. W. Simpson
W. J. Sparks

1970 - 1971

H. G. Busignies, Chmn.
M. Chodorow
J. C. Fletcher[2]
E. R. Gilliland
H. B. Gotaas
S. W. Herwald
M. G. Holloway[3]
J. A. Logan
K. D. Nichols
L. T. Rader
E. Rechtin
P. Rosenberg
W. G. Shepherd
C. P. Siess
W. J. Sparks[4]

* Superscripts refer to explanatory notes, Page 83.

PROJECT COMMITTEE (Continued)

1971 - 1972

H. G. Busignies, Chmn.
M. Chodorow
D. N. Frey
H. B. Gotaas
H. Heffner
S. W. Herwald
J. E. Jacobs
R. I. Jaffee
J. E. Jonsson
J. A. Logan
K. D. Nichols
L. T. Rader
E. Rechtin
P. Rosenberg
C. P. Siess
W. G. Shepherd[5]

1972 - 1973

H. G. Busignies, Chmn.
M. Chodorow
D. N. Frey
H. B. Gotaas
W. J. Hall
H. Heffner
S. W. Herwald
J. E. Jacobs
R. I. Jaffee
J. E. Jonsson
J. A. Logan
K. D. Nichols
L. T. Rader
E. Rechtin
P. Rosenberg

1973 - 1974

C. D. Perkins, Chmn.
D. N. Frey
H. B. Gotaas
W. J. Hall
H. Heffner
J. E. Jonsson
J. A. Logan

1974 - 1975

C. D. Perkins, Chmn.
S. J. Buchsbaum
H. W. Emmons
E. J. Gornowski[6]
H. Heffner[7]
W. J. Hall
G. S. Schairer

Explanatory Notes:

1. Mindlin: resigned effective September 5, 1968.

2. Fletcher: resigned effective May 25, 1971.

3. Holloway: resigned effective September 19, 1970.

4. Sparks: resigned effective March 3, 1971.

5. Shepherd: resigned effective August 23, 1971.

6. Gornowski: resigned effective September 20, 1974.

7. Heffner: resigned effective September 20, 1974.

APPENDIX IV

ADVISORY ACTIVITIES
of the
National Academy of Engineering

The committees and boards listed in this appendix comprise those advisory activities for which the NAE had sole administrative responsibility prior to the promulgation of the "Statement of Principles Underlying Joint Governance of the NRC by the NAS and NAE" on July 1, 1974.

Primary sources used in collating the material herein were: Annual Reports to the Congress for the National Academy of Sciences corporation (fiscal years 1964 - 1975); Organization and Members books covering the committee structure of the various elements comprising the NAS corporation (1964 - 1975); and minutes of meetings of the NAE Council and its Executive Committee for the same period. Committee reports were referred to also for pertinent information. Additionally, the rosters of those committees and boards which were transferred to the Assembly of Engineering of the NRC upon its establishment in July, 1974, and are still in operation, were verified by the respective principal staff officers. Exact dates of establishment and discharge of the various units are shown wherever possible.

AERONAUTICS AND SPACE ENGINEERING BOARD

The board shall survey the problems, the opportunities, and the implications of aeronautical developments and of man's advance into space and shall look for ways to develop wise and vigorous national engineering, scientific, and educational programs as applied to aerospace. The board and its committees will make recommendations as to what engineering objectives are attainable and the priority that should be accorded them, as to how to bring engineering talents to bear on aerospace problems of national importance, and as to how to improve engineering education, including the enhancement of public responsibility on the part of engineers in these areas. The board shall have advisory and consultative responsibilities, responding to specific requests for assistance as well as taking the initiative when appropriate.

85

1966 - 1967

H. G. Stever, Chmn.
R. L. Bisplinghoff, V. Chmn.
L. L. Beranek
W. M. Hawkins
R. F. Mettler
A. E. Puckett
E. C. Wells

1967 - 1968

H. G. Stever, Chmn.
R. L. Bisplinghoff, V. Chmn.
L. L. Beranek
W. M. Hawkins
J. M. Kyle, Jr.
R. F. Mettler
B. M. Oliver
P. W. Pratt
A. E. Puckett
G. E. Solomon
E. C. Wells
C. C. Wood

1968 - 1969

H. G. Stever, Chmn.
R. L. Bisplinghoff, V. Chmn.
L. L. Beranek
E. J. Barlow
A. H. Flax
W. M. Hawkins
R. Kompfner
J. M. Kyle, Jr.
W. C. Mentzer
R. H. Miller
B. M. Oliver
P. W. Pratt
A. E. Puckett
D. B. Sinclair
G. E. Solomon
E. C. Wells
C. C. Wood

AERONAUTICS AND SPACE ENGINERING BOARD (Continued)

1969 - 1970

R. L. Bisplinghoff, Chmn.
W. M. Hawkins, V. Chmn.
E. J. Barlow
A. H. Flax
R. Kompfner
J. M. Kyle, Jr.
W. C. Mentzer
R. H. Miller
B. M. Oliver
P. W. Pratt
A. E. Puckett
D. B. Sinclair
G. E. Solomon
H. G. Stever
C. C. Wood

1970 - 1971

R. L. Bisplinghoff, Chmn.
W. M. Hawkins, V. Chmn.
H. J. Allen
A. E. Bryson, Jr.
A. F. Donovan
A. H. Flax
A. C. Hall
R. Kompfner
J. M. Kyle, Jr.
B. McMillan
W. C. Mentzer
R. H. Miller
B. M. Oliver
P. W. Pratt
A. E. Puckett
D. B. Sinclair
G. E. Solomon
H. G. Stever
G. K. Teal
C. H. Townes*
C. C. Wood

1971 - 1972

W. M. Hawkins, Chmn.
R. Kompfner, V. Chmn.
H. J. Allen
A. E. Bryson, Jr.
A. F. Donovan
A. H. Flax
A. C. Hall
B. McMillan
W. C. Mentzer
R. H. Miller
A. E. Puckett
A. Silverstein
D. B. Sinclair
G. E. Solomon
G. K. Teal
C. H. Townes*

* Ex officio, Chairman, NAS Space Science Board.

AERONAUTICS AND SPACE ENGINEERING BOARD (Continued)

1972 - 1973	1973 - 1974	1974 - 1975
W. M. Hawkins, Chmn.	W. M. Hawkins, Chmn.	G. E. Solomon, Chmn.
R. Kompfner, V. Chmn.	G. E. Solomon, V. Chmn.	A. E. Bryson, Jr., V. Chmn.
H. J. Allen	H. J. Allen	L. L. Beranek
L. L. Beranek	L. L. Beranek	R. H. Botlin
A. E. Bryson, Jr.	A. E. Bryson, Jr.	R. H. Cannon, Jr.
A. F. Donovan	A. J. Eggers, Jr.	J. V. Charyk
A. Ferri	A. F. Donovan	A. J. Eggers, Jr.
A. H. Flax	A. Ferri	A. Ferri
P. C. Goldmark	M. E. Fine	M. E. Fine
D. J. Jordan	A. H. Flax	R. R. Gilruth
R. W. Ketchledge	R. M. Goody*	R. M. Goody*
W. B. McLean	D. J. Jordan	D. J. Jordan
B. McMillan	R. W. Ketchledge	R. W. Ketchledge
R. H. Miller	L. Lees	L. Lees
A. E. Puckett	H. W. Liepmann	F. W. Lehan
W. R. Sears	R. G. Loewy	H. W. Liepmann
A. Silverstein	W. B. McLean	R. G. Loewy
D. B. Sinclair	R. H. Miller	W. B. McLean
G. E. Solomon	A. E. Puckett	R. H. Miller
G. K. Teal	R. W. Rummel	M. L. Pennell
C. H. Townes*	W. R. Sears	A. E. Puckett**
	A. Silverstein	R. W. Rummel
	D. B. Sinclair	A. Silverstein
	C. H. Townes	D. B. Sinclair
	A. D. Wheelon	A. D. Wheelon

87

* Ex officio, Chairman, NAS Space Science Board.

** Ex officio, Chairman, NAE Space Applications Board.

Established, March 27, 1967.
Transferred to the Assembly of Engineering, July 1, 1974.

BAY AREA RAPID TRANSIT (BART) IMPACT PROGRAM ADVISORY COMMITTEE

The committee shall provide advisory services to the Department of Transportation and the Department of Housing and Urban Development in the program design phase of a series of research studies which are to determine the many effects on the San Francisco Bay Area which may be attributable to the Bay Area Rapid Transit (BART) System. The committee, in a second phase of the studies, will continue its advisory role during the implementation of the program.

1972 - 1973	1973 - 1974	1974 - 1975
S. W. Herwald, Chmn.	S. W. Herwald, Chmn.	S. W. Herwald, Chmn.
M. Cafferty	J. D. Carroll, Jr.	J. D. Carroll, Jr.
J. D. Carroll, Jr.	W. L. Garrison	H. B. Finger
W. L. Garrison	P. C. Goldmark	W. L. Garrison
P. C. Goldmark	B. Harris	P. C. Goldmark
B. Harris	S. Z. Klausner	B. Harris
S. Z. Klausner	E. S. Lee	S. Z. Klausner
E. S. Lee	M. L. Manheim	E. S. Lee
M. L. Manheim	W. Owen	M. L. Manheim
W. Owen	M. Pikarsky	W. Owen
P. Ratoosh	P. Ratoosh	M. Pikarsky
J. P. Romualdi	J. P. Romualdi	P. Ratoosh
W. M. Spreitzer	W. M. Spreitzer	J. P. Romualdi
K. E. F. Watt	K. E. F. Watt	W. M. Spreitzer
E. C. Wells	E. C. Wells	K. E. F. Watt
		E. C. Wells

Established, July 1, 1972.
Transferred to the Assembly of Engineering, July 1, 1974.

AD HOC COMMITTEE FOR THE BUREAU OF MINES

The committee will undertake a review and evaluation of the research programs and the mineral intelligence and mineral information activities of the Bureau of Mines. Consideration will be given to their timeliness, effectiveness, and adequacy of financial support. As a result of this review and evaluation, the committee will determine the need for a National Academy of Engineering Standing Committee with panels, as appropriate, to provide continuous advice and guidance on the technical research programs, their priorities, and the adequacy of supporting resources. If the ad hoc committee deems it desirable to establish a standing committee, a proposed program of committee activities and functions will be developed.

89

1972 - 1973

O. T. Marzke, Chmn.
C. F. Barber
E. H. Beistline
J. P. Brennan
M. D. Hassialis
C. R. Hocott
G. E. Kruger
I. K. MacGregor
G. T. McBride, Jr.
G. D. Michaelson
W. C. Schroeder
S. H. Schurr
K. Schwartzwalder
E. A. Walker
J. P. Weir

Established, July, 1972.
Discharged, July, 1973.

AD HOC COMMITTEE ON CONFERENCE ON SUMMER EMPLOYMENT OF GRADUATE AND UNDERGRADUATE ENGINEERING STUDENTS

To explore the possibility of arranging a small, one-day invitational conference in cooperation with the Engineers Joint Council and the Institute of Electrical and Electronics Engineers for the discussion of ways in which full participation by industry in a program of summer employment of undergraduate and graduate engineering students can take place.

1965 - 1966

J. R. Pierce, Chmn.
T. C. Kavanagh
E. Weber

Established, April 28, 1965.
Discharged, May 25, 1966.

AD HOC COMMITTEE TO WORK WITH A COMMITTEE OF THE ENGINEERING FOUNDATION

The committee shall explore the interest of NAE/NRC in assuming responsibility for the Engineering Foundation Councils.

1966 - 1967, 1967 - 1968

A. M. Gaudin, Chmn.
A. C. Monteith
L. Smith

Established, April 28, 1966.
Discharged, August 31, 1967.

COMMITTEE ON CONTROL OF WASTES IN AIR, WATER, AND THE LAND

The committee shall make specific recommendations to the Project Committee with regard to the provisions of advice on national needs and programs in waste control.

1966 - 1967

F. A. L. Holloway, Chmn.
K. L. Fetters
T. K. Sherwood
A. Wolman

Established, April 28, 1966.
Discharged, November 16, 1967.

COMMISSION ON EDUCATION*

Established to initiate, monitor, coordinate
advise on programs and policies influencing
nological education and technology for education.

1968 - 1969	1969 - 1970	1970 - 1971
G. S. Brown, Chmn.	G. S. Brown, Chmn.	W. R. Marshall, Chmn.
E. E. David, Jr., V. Chmn.	W. R. Marshall, V. Chmn.	F. H. Clauser, V. Chmn.
R. H. Bolt	R. H. Bolt	R. H. Bolt
A. B. Cambel	A. B. Cambel	G. S. Brown
C. C. Chambers[1]	P. F. Chenea	G. Bugliarello
P. F. Chenea	F. H. Clauser	A. B. Cambel
D. N. Frey	E. E. David, Jr.	E. E. David, Jr.
H. H. Goldstine	N. A. Hall	D. C. Evans
N. A. Hall	W. D. Lewis	L. M. Field
W. R. Hibbard, Jr.	B. S. Old	N. A. Hall
W. R. Marshall,	M. S. Peters	G. A. Hawkins[1]
O. T. Marzke	J. M. Pettit	W. D. Lewis
N. M. Newmark	A. Schultz, Jr.	B. S. Old
M. S. Peters	C. Starr	J. M. Pettit
A. Schultz, Jr.	H. L. Thurman, Jr.	A. Schultz, Jr.
C. Starr	J. G. Truxal	H. A. Simon
H. L. Thurman, Jr.	E. Weber[2]	C. Starr
J. G. Truxal	J. R. Whinnery	J. G. Truxal
E. Weber[2]	M. A. Wiliamson[1]	E. Weber[2]
J. R. Whinnery	E. L. Zebroski	E. L. Zebroski

* Cf. Board on Engineering Manpower and Education Policy, Page 93.

1. Ex officio, President, American Society for Engineering Education.

2. Ex officio, President, Engineers Council for Professional Development.

COMMISSION ON EDUCATION (Continued)

1971 - 1972

W. R. Marshall, Chmn.
J. G. Truxal, V. Chmn.
R. H. Bolt
H. A. Bolz[1]
G. S. Brown
G. Bugliarello
D. C. Evans
L. M. Field
J. Fisher
E. P. Gyftopoulos
N. A. Hall
M. R. Lohman[2]
T. L. Martin, Jr.
B. S. Old
J. M. Pettit
L. T. Rader
A. Schultz, Jr.
C. Starr
C. A. Wedemeyer
E. L. Zebroski

92

1972 - 1973, 1973 - 1974

W. R. Marshall, Chmn.
J. G. Truxal, V. Chmn.
H. A. Bolz[1]
G. Bugliarello
D. C. Evans
L. M. Field
J. Fisher
E. P. Gyftopoulos
N. A. Hall
M. R. Lohman[2]
T. L. Martin, Jr.
L. T. Rader
A. Schultz, Jr.
C. Starr
C. A. Wedemeyer

1. Ex officio, President, American Society for Engineering Education.

2. Ex officio, President, Engineers Council for Professional Development.

Established, November 4, 1968.
Discharged, May, 1974.

BOARD ON ENGINEERING MANPOWER AND EDUCATION POLICY*

Established as a successor to the NAE Commission on Education with an expansion in scope of activities. The objectives of the board are two-fold: (a) to define and address the problems associated with improving the match between supply and demand of the nation's engineering manpower, and (b) to define and address educational policy problems associated with improving the quality and effectiveness of education for the engineering profession.

1973 - 1974

M. E. Van Valkenburg, Chmn.
C. C. Cutler
E. J. Gornowski
R. G. Loewy
D. O. Pederson
M. Tribus

1974 - 1975

M. E. Van Valkenburg, Chmn.
C. C. Cutler
N. D. Fitzroy
E. J. Gornowski
R. G. Loewy
D. O. Pederson
F. E. Richart, Jr.
M. Tribus
J. N. Warfield

* Cf. Commission on Education, Page 91.

Established, February 8, 1974.
Transferred to the Assembly of Engineering, July 1, 1974.

COMMITTEE ON ENGINEERING MANPOWER POLICY

Established to study the major influences on the nature and stability of engineering employment and to recommend remedial actions. The study will include economic, political, sociological, legislative, managerial and technological factors which may have primary impact on the situation, and inference will be drawn as to how these factors might be affected to achieve desired engineering manpower goals consistent with national priorities.

1971 - 1972, 1972 - 1973

B. O. Evans, Chmn.
P. M. Arnold
J. A. Blume
P. F. Chenea
A. Gilmore
E. Ginzberg
H. Heffner
T. F. Jones
B. McMillan
M. L. Pennell

Established, October, 1971.
Discharged, July, 1973.

TASK FORCE ON ENERGY

Established to define and describe a government/industry program which will substantially increase the U.S. domestic energy supply (and/or decrease the domestic energy supply deficit) by 1980 or the early 1980s.

1973 - 1974

W. K. Davis, Chmn.
W. C. Ackermann
R. G. Folsom
J. H. Hollomon
F. A. L. Holloway
L. Lees
T. O. Paine
L. H. Roddis, Jr.
T. K. Sherwood
M. Tribus
H. S. Turner

Established, December 13, 1973.
Discharged, May, 1974.

TASK FORCE ON ENERGY PROGRAM PLANNING

Established to develop in detail within the next six months recommendations for not more than three action programs in the energy field which are judged to be feasible for completion by units of the NAE and/or the NRC in a timely manner; the final recommendations of the task force in this regard should include information regarding the specific results which are anticipated, the manner in which the information is expected to be utilized and by whom; the estimated funding required, and government agencies or other organizations who are viewed as potential sponsors of the work should also be identified.

1973 - 1974

W. K. Davis, Chmn.
W. C. Ackermann
R. G. Folsom
J. H. Hollomon
F. A. L. Holloway
L. Lees
T. O. Paine
H. S. Turner

Established, October 1, 1973.
Discharged, Summer, 1973.

COMMITTEE ON ENVIRONMENTAL ENGINEERING*

Established to pinpoint critical environmental problems and set in motion mechanisms for clarifying and defining the issues to be resolved. The committee will make recommendations to the NAE Council, and the Environmental Studies Board, and other appropriate groups regarding priority programs and action required to initiate such programs. The committee will also direct the development and implementation of NAE programs and will most effectively utilize the talents and interests of the Academy members in combination with other individuals or groups necessary to perform selected tasks.

95

1969 - 1970

W. C. Ackermann, Chmn.
F. A. L. Holloway
H. E. Landsberg
J. E. McKee
E. F. Osborn
L. Squires
E. Wenk, Jr.

1970 - 1971

W. C. Ackermann, Chmn.
E. G. Fubini
F. A. L. Holloway
H. E. Landsberg
J. E. McKee
E. F. Osborn
L. Squires
E. Wenk, Jr.

1971 - 1972

W. C. Ackermann, Chmn.
J. C. Frye
E. G. Fubini
F. A. L. Holloway
H. E. Landsberg
J. E. McKee
E. F. Osborn
L. Squires
E. Wenk, Jr.

1972 - 1973

W. C. Ackermann, Chmn.
J. C. Frye
E. G. Fubini
F. A. L. Holloway
H. E. Landsberg
J. E. McKee
E. F. Osborn
L. Squires
E. Wenk, Jr.

1973 - 1974

W. C. Ackermann, Chmn.
J. C. Frye
F. A. L. Holloway
H. E. Landsberg
J. E. McKee
E. F. Osborn
L. Squires
E. Wenk, Jr.

* Formerly the Committee on Engineering Aspects of Environmental Quality.

Established, February 6, 1970.
Transferred to the Assembly of Engineering, July 1, 1974.

AD HOC COMMITTEE TO DETERMINE THE FEASIBILITY OF PROVIDING ADVISORY SERVICES IN THE FIELD OF ENGINEERING IN MEDICINE AND BIOLOGY*

The committee shall determine the feasibility of providing advisory services in the field of engineering in medicine and biology.

1966 - 1967, 1967 - 1968

J. E. McKeen, Chmn.
E. E. David, Jr.
A. B. Kinzel
J. G. Truxal
V. K. Zworykin

96

* Cf. Committee on the Interplay of Engineering with Biology and Medicine, Page 99; Ad Hoc Committee to Review the Need for Activities of the National Academy of Engineering in the Field of Engineering in Medicine and Biology, Page 107; U.S. National Committee on Engineering in Medicine and Biology, Page 123.

Established, October 6, 1966.
Discharged, July 13, 1967.

AD HOC FELLOWSHIP PROGRAM COMMITTEE

The committee shall investigate the total area of government support of engineering education, in particular the area of scholarships and fellowships, and to make recommendations to the Council of the National Academy of Engineering for actions by the Academy in these areas.

1965 - 1966

G. H. Brown, Chmn.
E. H. Heinemann
F. A. L. Holloway
N. M. Newmark
E. Weber

Established, March 17, 1965.
Discharged, May 25, 1966.

COMMITTEE ON INDUSTRIALIZED HOUSING

The committee shall assess the role, if any, large American corporations might play in the provision of housing through the development of a sophisticated new mass production technology.

1970 - 1971, 1971 - 1972

E. A. Walker, Chmn.
G. C. McGhee
A. Spilhaus
J. C. Warner
T. C. Kavanagh

Established, December, 1970.
Discharged, May, 1972.

INTEGRATED UTILITY SYSTEMS BOARD

Established by the National Academy of Engineering to review studies of the integrated utility systems concept and analyze data on various implemented and conceptual integrated utility systems. The board's work will be designed to assist the Department of Housing and Urban Development and other government agencies in evaluating the practicality of developing processing plants capable of serving all the utility needs of future community development.

1972 - 1973, 1973 - 1974

G. O. Wessenauer, Chmn.
S. W. Gouse, Jr., V. Chmn.
V. W. Bacon
J. G. Abert
F. S. Dubin
J. Kretchmer
F. C. Lindvall
W. Lu
L. H. Roddis, Jr.
W. E. Shoupp
J. C. Swidler

Established, September 1, 1972.
Transferred to the Assembly of Engineering, July 1, 1974.

COMMITTEE ON INTERNATIONAL ACTIVITIES

To advise the Council and the Foreign Secretary with respect to policies, programs, and personnel in the field of international activities of the Academy.

1970 - 1971

B. S. Old, Chmn.
P. M. Arnold
J. Boyd
C. C. Chambers
W. L. Cisler
N. Cohn
W. K. Davis
A. M. Gaudin
H. B. Gotaas
H. E. Hoelscher
A. T. Ippen
R. I. Jaffee
F. C. Lindvall
J. A. Logan
H. Rouse
D. B. Sinclair
G. K. Teal

Established, May 1, 1970.
Discharged, May 1, 1971.

COMMITTEE ON THE INTERPLAY OF ENGINEERING WITH BIOLOGY AND MEDICINE*

The committee shall identify and broadly define some program opportunities and needs on the basis of current engineering theory and practice, and the applicability of them to problems of biology and medicine. The committee acts in an advisory role primarily to the National Institutes of Health, and secondarily to other government agencies concerned with the support and encouragement of engineering in biology and medicine. The committee will also work to delineate clearly the characteristics and limitations of modern engineering and the means by which the national engineering capability can be effectively directed towards the fundamental and applied problems of concern to the National Institutes of Health.

1968 - 1969	1969 - 1970	1970 - 1971
J. C. Truxal, Chmn.	W. R. Marshall, Chmn.	W. R. Marshall, Chmn.
E. S. Bennett	D. A. Brody	E. R. Buskirk
D. A. Brody	E. R. Buskirk	C. A. Caceres
E. R. Buskirk	M. Eden	M. Eden
W. E. Cushen	R. H. Egdahl	C. D. Flagle
E. E. David, Jr.	C. D. Flagle	D. E. Harken
M. Eden	L. D. Harmon	L. D. Harmon
R. H. Egdahl	J. H. Irving	J. H. Irving
J. H. Irving	A. B. Kinzel	A. B. Kinzel
J. E. Jacobs	W. K. Linvill	A. Latham, Jr.
A. B. Kinzel	R. W. Mann	W. K. Linvill
W. K. Linvill	E. M. Papper	R. W. Mann
W. R. Marshall	D. D. Rutstein	S. Padwo
E. M. Papper	J. G. Truxal	L. Podolsky
R. F. Rushmer	V. K. Zworykin	D. D. Rutstein
D. D. Rutstein		J. G. Truxal
V. K. Zworykin		H. R. Weed
		V. K. Zworykin

99

* Cf. Ad hoc Committee to Determine the Feasibility of Providing Advisory Services in the Field of Engineering in Medicine and Biology, Page 96; Ad hoc Committee to Review the Need for Activities of the National Academy of Engineering in the Field of Engineering in Medicine and Biology, Page 107; U.S. National Committee on Engineering in Medicine and Biology, Page 123.

COMMITTEE ON THE INTERPLAY OF ENGINEERING WITH BIOLOGY AND MEDICINE (Continued)

1971 - 1972

W. R. Marshall, Chmn.
D. A. Brody
E. R. Buskirk
C. A. Caceres
M. Eden
C. D. Flagle
D. E. Harken
L. D. Harmon
J. H. Irving
A. B. Kinzel
A. Latham, Jr.
W. K. Linvill
R. W. Mann
S. Padwo
L. Podolsky
D. D. Rutstein
J. G. Truxal
H. R. Weed
V. K. Zworykin

1972 - 1973

W. R. Marshall, Chmn.
D. A. Brody
E. R. Buskirk
C. A. Caceres
M. Eden
C. D. Flagle
D. E. Harken
L. D. Harmon
J. H. Irving
A. B. Kinzel
A. Latham, Jr.
W. K. Linvill
R. W. Mann
S. Padwo
L. Podolsky
D. D. Rutstein
J. G. Truxal
H. R. Weed
V. K. Zworykin

Established, June, 1967.
Discharged, September, 1973.

MARINE BOARD*

Established as a focus of engineering expertise and concern to provide advice on the conception, formulation, and evaluation of national policies, programs, and organizations pertinent to the enhancement and utilization of the marine environment and its resources for the public welfare and defense. The board also serves as the U. S. National Committee for the International Engineering Committee on Oceanic Resources.

1964 - 1965

T. C. Kavanagh, Chmn.
H. A. Arnold
H. E. Edgerton
L. Griffis
E. H. Heinemann
J. D. Isaacs
E. A. Link
A. E. Maxwell
T. Saville

1965 - 1966

T. C. Kavanagh, Chmn.
H. A. Arnold
H. E. Edgerton
L. Griffis
E. H. Heinemann
J. D. Isaacs
E. A. Link
A. E. Maxwell
T. Saville

1966 - 1967

T. C. Kavanagh, Chmn.
H. E. Edgerton
L. Griffis
E. H. Heinemann
J. D. Isaacs
E. A. Link
A. E. Maxwell
T. Saville

1967 - 1968

T. C. Kavanagh, Chmn.
W. C. Bachman
L. L. Beranek
R. H. Boundy
A. M. Gaudin
L. Griffis
E. H. Heinemann
A. A. H. Keil
C. G. Kirkbride
E. A. Link
A. E. Maxwell
G. C. Nickum
E. A. Pearson
C. F. Prutton
T. Saville
W. E. Shoupp
E. P. Wheaton

1968 - 1969

T. C. Kavanagh, Chmn.
W. C. Bachman
L. L. Beranek
R. H. Boundy
A. M. Gaudin
L. Griffis
J. M. Hait
E. H. Heinemann
A. A. H. Keil
C. G. Kirkbride
E. A. Link
A. E. Maxwell
G. C. Nickum
E. A. Pearson
W. E. Shoupp
E. P. Wheaton

1969 - 1970

T. C. Kavanagh, Chmn.
H. A. Arnold
W. C. Bachman
L. L. Beranek
R. H. Boundy
A. M. Gaudin
L. Griffis
J. M. Hait
E. H. Heinemann
A. A. H. Keil
J. R. Kiely
E. A. Link
A. E. Maxwell
G. C. Nickum
E. A. Pearson
W. E. Shoupp
E. P. Wheaton

* Formerly the Committee on Ocean Engineering.

MARINE BOARD (Continued)

1970 - 1971

W. E. Shoupp, Chmn.
W. C. Bachman
L. L. Beranek
R. H. Boundy
A. M. Gaudin
L. Griffis
J. M. Hait
E. H. Heinemann
A. A. H. Keil
J. R. Kiely
E. A. Link
A. E. Maxwell
G. C. Nickum
E. A. Pearson
E. P. Wheaton

1971 - 1972

W. E. Shoupp, Chmn.
W. C. Bachman
R. F. Bauer
L. L. Beranek
J. P. Craven
H. W. Fisher
A. M. Gaudin
E. H. Heinemann
C. R. Hocott
A. T. Ippen
T. C. Kavanagh
A. A. H. Keil
E. A. Link
G. C. Nickum
E. A. Pearson
W. B. W. Rand
H. E. Sheets
E. P. Wheaton
V. Boatwright**
G. F. Mechlin**

1972 - 1973

W. E. Shoupp, Chmn.
W. C. Bachman
R. F. Bauer
J. P. Craven
H. W. Fisher
A. M. Gaudin
C. R. Hocott
A. T. Ippen
A. A. H. Keil
J. R. Kiely
E. A. Link
A. E. Maxwell
G. C. Nickum
E. A. Pearson
W. B. W. Rand
H. W. Sheets
E. P. Wheaton
V. Boatwright**
G. F. Mechlin**
O. D. Waters**
R. L. Wiegel**

1973 - 1974

W. E. Shoupp, Chmn.
W. C. Bachman
R. R. Bauer
J. P. Craven
H. W. Fisher
A. M. Gaudin
B. C. Gerwick, Jr.
E. F. Gloyna
C. R. Hocott
A. T. Ippen

1973 - 1974 (Continued)

A. A. H. Keil
J. R. Kiely
C. J. Lambertsen
E. A. Link
G. C. Nickum
E. A. Pearson
W. B. W. Rand
H. W. Sheets
J. H. Wakelin, Jr.
E. P. Wheaton

1974 - 1975

A. A. H. Keil, Chmn.
W. C. Bachman
J. P. Craven
J. E. Flipse
R. L. Geer
B. C. Gerwick, Jr.
E. R. Gloyna
C. R. Hocott
J. R. Kiely

1974 - 1975 (Continued)

C. J. Lambertsen
G. F. Mechlin
G. C. Nickum
E. A. Pearson
H. E. Sheets
J. H. Wakelin
R. L. Wiegel
E. P. Wheaton

** Ex officio, Chairmen of ad hoc panels or committees.

Established, March 17, 1965.
Transferred to the Assembly of Engineering, July 1, 1974.

COMMITTEE ON MINE RESCUE AND SURVIVAL TECHNIQUES

Established to conduct a study program to assess the technological capabilities that can be applied to survival and rescue techniques following mining disasters. The committee will investigate the application of military, aerospace, and other advanced technology to improving the effectiveness of existing devices and to describing the technological possibilities of new devices or equipment to improve workers' chances of survival in the environments that prevail following mine disasters.

1969 - 1970

W. R. Hibbard, Jr., Chmn.
A. Chambers
B. G. Giel
G. Hair
G. B. Keller
J. F. Lederer
W. C. Maurer
W. G. Talman
T. N. Williamson

Established, March, 1969.
Discharged, March, 1970.

COMMITTEE ON MINORITIES IN ENGINEERING

The program on minorities in engineering was established by the National Academy of Engineering to provide national leadership in coordinating a nationwide effort aimed at achieving a tenfold increase in minority engineering graduates within a decade. The program comprised the advisory activities of a National Council on Minorities in Engineering and the operating activities of a standing Committee on Minorities in Engineering.

1973 - 1974	1974 - 1975
R. J. Grosh, Chmn.	A. G. Hansen, Chmn.
A. G. Hansen, V. Chmn.	P. A. Pierre, V. Chmn.
P. Barron	L. B. Anderson
J. A. Baird	J. A. Baird
J. E. Bostic, Jr.	P. Barron
H. R. Branson	H. R. Branson
R. W. Bromery	R. W. Bromery
C. H. Conliffe	R. Bromberg
C. DeLeon	C. H. Conliffe
C. Dennard	C. DeLeon
D. Ford	E. F. Fields
P. E. Gray	D. Fore
J. A. Haddad	E. L. Gaden, Jr.
W. R. Marshall	J. W. Gibson
P. McDonald	P. E. Gray
J. E. Milano	A. E. Greaux
T. J. Olsen	R. J. Grosh
P. A. Pierre	W. L. Hawkins
L. E. Saline	J. W. Hernandez
A. Schultz, Jr.	R. N. Mills
H. B. Smith, Jr.	R. F. Neblett
M. Tanenbaum	L. Padulo
M. Thompson	H. W. Paxton
R. C. Seamans, Jr.*	E. R. Reyes-Guerra
	H. B. Smith, Jr.
	M. Thompson

* Ex officio, President of the NAE.

Established, September 17, 1973.
Transferred to the Assembly of Engineering, July 1, 1974.

National Advisory Council on Minorities in Engineering

1973 - 1974

R. H. Jones, Chmn.
R. J. Grosh, V. Chmn.
H. Ashley
S. D. Bechtel, Jr.
L. M. Branscomb
P. J. Brennan
A. F. Brimmer
D. C. Burnham
J. C. Calhoun
J. D. deButts
J. Z. DeLeon
A. de los Santos, Jr.
J. D. Harper
T. M. Hesburgh
J. K. Jamieson
V. E. Jordan
E. R. Kane
M. R. Laird
A. C. Mair
C. P. McColough
R. W. Samoff
R. C. Seamans, Jr.*
E. B. Speer
H. G. Stever
L. H. Sullivan
J. F. Towey
A. B. Trowbridge
C. W. Weinberger
R. Wilkins
F. P. Wilson

1974 - 1975

R. H. Jones, Chmn.
A. G. Hansen, V. Chmn.
R. S. Ahlbrandt
R. O. Anderson
S. D. Bechtel, Jr.
L. M. Branscomb
D. C. Burnham
C. A. Cash
J. E. Cheek
W. T. Coleman, Jr.
J. P. Condon
A. L. Conrad
M. R. Currie
J. D. deButts
A. de los Santos, Jr.
C. Edley
L. W. Foy
C. C. Garvin, Jr.
J. E. Goldman
M. Gonzalez
W. R. Goodwin
T. C. Graham
M. F. Granville
V. L. Gregory
J. W. Hanley
J. D. Harper
L. Harrisberger
J. M. Henske
T. M. Hesburgh
V. E. Jordan

1974 - 1975 (Continued)

E. R. Kane
J. W. Kettle
H. C. MacDonald
A. C. Mair
J. Martin
D. Mathews
G. V. Myers
T. W. Nelson
W. R. Orthwein, Jr.
C. D. Perkins*
L. Perry
C. J. Pilliod, Jr.
W. F. Rockwell, Jr.
R. C. Seamans, Jr.
W. E. Scott
C. D. Siverd
J. S. Smith
E. B. Speer
H. G. Stever
L. H. Sullivan
A. B. Trowbridge
C. W. Verity, Jr.
L. H. Warner
R. Wilkins
R. P. Wilson

* Ex officio, President of the NAE.

Established, September 17, 1973.
Transferred to the Assembly of Engineering, July 1, 1974.

AD HOC STUDY PANEL OF THE NATIONAL SCIENCE FOUNDATION
EXPERIMENTAL RESEARCH AND DEVELOPMENT INCENTIVES PROGRAM

The ad hoc study panel will review the organization, planning, proposed direction, and development of the NSF Experimental R&D Program, including additional experimental solutions involving financial incentives under consideration by the Foundation. The panel will also consider the problem of moving federally funded R&D into civilian applications.

1972 - 1973

L. Squires, Chmn.
A. O. Beckman
E. J. Brenner
M. R. Currie
J. E. Gorham
E. J. Gornowski
R. W. Gould
W. J. Haas
L. R. Hafstad
J. Hillier
D. G. Marquis
J. P. Mitchell
B. S. Old
J. W. Simpson
M. Tanenbaum
E. A. Walker
J. W. Whelan

1973 - 1974

E. J. Gornowski, Chmn.
T. J. Allen
A. O. Beckman
E. J. Brenner
J. E. Gorham
W. J. Haas
L. R. Hafstad
J. Hillier
J. P. Mitchell
B. S. Old
F. N. Piasecki
J. W. Simpson
L. Squires
M. Tanenbaum
E. A. Walker
J. W. Whelan

Established, October 1, 1972
Discharged, June, 1974.

NATIONAL SCIENCE FOUNDATION LIAISON COMMITTEE

Established to explore with the Division of Engineering of the National Science Foundation ways in which the National Academy of Engineering could provide guidance, criteria, and statements of research needs in the several engineering disciplines to the National Science Foundation; to explore the kind of structure that should be developed to make engineering advice more readily available for studies that have scientific objectives but need engineering tools and instruments; and to make recommendations with regard to the above items to the Council of the National Academy of Engineering.

1965 - 1966

G. E. Holbrook, Chmn.
R. G. Folsom
N. M. Newmark

Established, September 23, 1965.
Discharged, October 12, 1966.

AD HOC COMMITTEE TO REVIEW THE NEED FOR ACTIVITIES OF THE NATIONAL ACADEMY OF ENGINEERING IN THE FIELD OF ENGINEERING IN MEDICINE AND BIOLOGY*

1965 - 1966

V. K. Zworykin, Chmn.
L. Carter
M. Eden
J. Kaugman
F. Leonard
R. L. Schoenfeld
A. Wolman

* Cf. Ad Hoc Committee to Determine the Feasibility of Providing Advisory Services in the Field of Engineering in Medicine and Biology, Page 96; Committee on the Interplay of Engineering with Biology and Medicine, Page 99; U.S. National Committee on Engineering in Medicine and Biology, Page 123.

Established, December 21, 1965.
Discharged, April 28, 1966.

TASK FORCE ON THE PATENT SYSTEM

The task force shall select appropriate areas for a National Academy of Engineering study of the patent system from a list provided by the Committee on Public Engineering Policy. It shall also recommend individuals for a Committee on the Patent System and investigate possible sources of funds for the work of the Committee.

1967 - 1968

C. S. Draper, Chmn.
C. E. Anagnostopoulos
L. Biebel
J. P. Eckert
C. C. Remsen, Jr.
R. H. Rines
H. G. Stever
C. G. Suits

Established, November 16, 1967.
Discharged, April 25, 1968.

COMMITTEE ON THE PATENT SYSTEM

Established to consider broadly how the patent system can make a maximum contribution to technological progress, now and in the future. The committee will consider, among other topics, and make recommendations on policies of the Federal Government with regard to patents issued under government-sponsored research; federal patents to be used by the public; the role of patents in the orderly progress of technology in industry and business; and the impact of new legislation on the value of our patent system in domestic and international commerce.

1968 - 1969

C. S. Draper, Chmn.
C. E. Anagnostopoulos
L. E. Biebel
E. R. Gilliland
J. C. Green
C. C. Remsen, Jr.
R. H. Rines
C. Starr
C. G. Suits
E. C. Wells

Established, April 25, 1968.
Discharged, 1969.

COMMITTEE ON POWER PLANT SITING

Established to identify ways in which good engineering can help to avoid adverse effects on the environment and to aid in avoiding unfavorable impacts on power supply. The study will include a review of existing or proposed approaches to power plant siting.

1970 - 1971, 1971 - 1972

W. D. Lewis, Chmn.
D. M. Robinson, V. Chmn.
S. I. Auerbach
D. F. Cavers
R. C. Clement
M. Eisenbud
S. D. Freeman
W. R. Gould
H. E. Landsberg
P. H. Lewis, Jr.
T. J. Nagel
S. H. Schurr
L. F. Sillin, Jr.
E. H. Snyder
J. C. Swidler
F. M. Warren
F. H. Warren
G. O. Wessenauer

Established, December, 1970.
Discharged, May, 1972.

ADVISORY COMMITTEE ON PROJECT GASOLINE*

Project Gasoline is the Office of Coal Research's project to develop a process for converting coal to gasoline at an economically attractive price. The committee is to make an engineering evaluation of the work that has been performed on Project Gasoline and estimate its technical possibilities for the future.

1970 - 1971

E. R. Gilliland, Chmn.
C. G. Kirkbride
S. Lawroski
M. S. Peters
C. F. Prutton

* Formerly Ad Hoc Committee on Project Gasoline, the committee was reconstituted as an advisory committee in March, 1970.

Established, January 1, 1970.
Discharged, October 31, 1971.

COMMITTEE ON PUBLIC ENGINEERING POLICY

Established to study and advise on the needs and opportunities of the engineering community, on the interrelationship of technology and governmental policy making, on methods of improving the management of technology to serve the needs of people and the changing needs of society, and, in aid of these, to address broad questions of national policy involving or affecting science and technology.

1966 - 1967

C. Starr, Chmn.
L. L. Beranek
P. E. Haggerty
H. T. Heald
F. A. L. Holloway
J. R. Pierce
S. Ramo

1967 - 1968

C. Starr, Chmn.
A. O. Beckman
L. L. Beranek
J. H. Dessauer
C. R. Furnas
T. K. Glennan
P. E. Haggerty
H. T. Heald
J. Hillier
F. A. L. Holloway
J. R. Killian, Jr.
J. R. Pierce
S. Ramo

1968 - 1969

C. Starr, Chmn.
A. O. Beckman
L. L. Beranek
J. H. Dessauer
P. E. Haggerty
J. Hillier
F. A. L. Holloway
J. R. Killian, Jr.
N. M. Newmark
J. R. Pierce
C. C. Furnas
M. Goland
L. R. Hafstad

1969 - 1970

C. Starr, Chmn.
J. R. Pierce, V. Chmn.
A. O. Beckman
L. L. Beranek
J. H. Dessauer
E. G. Fubini
M. Goland
L. R. Hafstad
J. Hillier
F. A. L. Holloway
J. R. Killian, Jr.
R. F. Mettler
N. M. Newmark

1970 - 1971

E. Werk, Jr., Chmn.
R. A. Bauer
L. L. Beranek
D. S. Berry
W. D. Carey
J. Fisher
E. G. Fubini
M. Goland
L. R. Hafstad
F. A. L. Holloway

1970 - 1971 (Continued)

J. R. Killian, Jr.
W. D. Lewis
R. F. Mettler
C. J. Meyers
N. M. Newmark
A. Silverstein
C. Starr
G. F. White
A. Wolman

COMMITTEE ON PUBLIC ENGINEERING POLICY (Continued)

1971 - 1972	1972 - 1973	1973 - 1974	1974 - 1975
E. Wenk, Jr., Chmn.	E. Wenk, Jr., Chmn.	E. Wenk, Jr., Chmn.	E. Wenk, Jr., Chmn.
V. W. Bacon	V. W. Bacon	V. W. Bacon	V. W. Bacon
R. A. Bauer	R. A. Bauer	R. A. Bauer	R. A. Bauer
S. S. Baxter	S. S. Baxter	S. S. Baxter	S. S. Baxter
D. S. Berry	D. S. Berry	G. S. Brown	W. D. Carey
W. D. Carey	G. S. Brown	W. D. Carey	D. C. Drucker
J. Fisher	W. D. Carey	J. V. Charyk	J. Fisher
J. W. Forrester	D. C. Drucker	D. C. Drucker	B. R. Gifford
E. G. Fubini	J. Fisher	J. Fisher	W. R. Hibbard, Jr.
M. Goland	M. Goland	B. R. Gifford	W. D. Lewis
F. A. L. Holloway	J. R. Killian, Jr.	W. R. Hibbard, Jr.	C. J. Meyers
J. R. Killian, Jr.	W. D. Lewis	A. A. H. Keil	M. Pikarsky
W. D. Lewis	R. F. Mettler	W. D. Lewis	N. W. Polsby
R. F. Mettler	C. J. Meyers	C. J. Meyers	L. H. Roddis, Jr.
C. J. Meyers	A. Silverstein	M. Pikarsky	A. Silverstein
N. M. Newmark	C. Starr	N. W. Polsby	C. Starr
A. Silverstein	G. F. White	L. H. Roddis, Jr.	M. Tribus
C. Starr	F. Williams	A. Silverstein	F. Williams
G. F. White	A. Wolman	C. Starr	A. Wolman
A. Wolman		F. Williams	
		A. Wolman	

Established, March 24, 1966.
Transferred to the Assembly of Engineering, July 1, 1974.

SPACE APPLICATIONS BOARD

Established to advise NASA and other goverment agencies on the application of space technology to national needs, emphasizing ways to augment its positive effects on society. Through a series of studies related to national needs and technological capabilities in space application areas, the board will assist in broadening the interest and understanding of industry, universities, government, and the public in the potential benefit of space applications to the nation and mankind.

An Organizing Committee was established to recommend to the NAE the composition, functions, and membership of the Board.

1972 - 1973*	1973 - 1974	1974 - 1975
A. E. Puckett, Chmn.	A. E. Puckett, Chmn.	A. E. Puckett, Chmn.
D. J. Fink	A. R. Baldwin	A. R. Baldwin
G. Gerbner	O. C. Boileau	O. C. Boileau
W. B. Heroy, Jr.	J. M. Campbell	J. M. Campbell
F. A. Johnson	J. F. Collins	J. F. Collins
S. Lenher	E. Q. Daddario	D. J. Fink
W. Magruder	D. J. Fink	L. H. Goldenson
G. E. Solomon	M. Foster	P. C. Goldmark
C. Starr	L. H. Goldenson	W. B. Heroy, Jr.
R. M. White	P. C. Goldmark	M. L. Johnson
S. G. Younkin	W. B. Heroy, Jr.	T. F. Malone
G. Zissis	M. L. Johnson	W. A. Nierenberg
	T. F. Malone	J. E. White
	W. A. Nierenberg	
	S. deJ. Osborne	
	J. E. White	

* Organizing Committee, dissolved March, 1973.

Established, February 1, 1972.
Transferred to the Assembly of Engineering, July 1, 1974.

COMMITTEE ON TECHNOLOGY ASSESSMENT

The committee shall conduct pilot technology assessments for the House Science and Astronautics Committee in the four fields of civil aeronautics, ocean engineering, biomedical engineering, and technological teaching aids.

1968 - 1969

G. S. Schairer, Chmn.
C. C. Furnas
T. C. Kavanagh
H. G. Stever
J. G. Truxal
J. R. Whinnery

1969 - 1970

G. S. Schairer, Chmn,
M. Goland
T. C. Kavanagh
H. G. Stever
J. C. Truxal
J. R. Whinnery

Established, January 18, 1968.
Discharged, October, 1970.

AD HOC COMMITTEE ON TECHNOLOGY TRANSFER AND UTILIZATION

Established at the request of the National Science Foundation to identify the major federal agencies that have conducted programs directed toward technology transfer and utilization; determine and describe the methods used by those agencies in advancing the programs; evaluate effectiveness of these methods; assess the extent to which these agencies have evaluated their own methods; and, on the basis of the background information developed, recommend policies that the NSF or the federal government should consider.

1973 - 1974

J. H. Newman, Chmn.
G. Black
R. W. Cairns
R. N. Foster
A. J. Gellman
H. P. Green
P. Homer
C. N. Kimball
L. Levy
W. S. Martin
B. S. Old
J. R. Perrin
H. J. Sarles
E. A. Walker
J. F. Young

Established, July, 1973.
Discharged, February, 1974.

COMMITTEE ON TELECOMMUNICATIONS

Established to provide advice to the federal goverment on telecommunications technology and its relationship to national policies and programs.

1967 - 1968	1968 - 1969	1969 - 1970	1970 - 1971
W. L. Everitt, Chmn.	W. L. Everitt, Chmn.	W. L. Everitt, Chmn.	W. L. Everitt, Chmn.
E. R. Piore, V. Chmn.	E. R. Piore, V. Chmn.	E. R. Piore, V. Chmn.	R. Adler
R. Adler	R. Adler	R. Adler	H. G. Busignies
H. G. Busignies	H. G. Busignies	H. G. Busignies	R. P. Gifford
P. C. Goldmark	R. P. Gifford	R. P. Gifford	R. A. Henle
J. Hillier	P. C. Goldmark	P. C. Goldmark	J. Hillier
E. C. Jordan	J. Hillier	J. Hillier	E. C. Jordan
K. G. McKay	E. C. Jordan	E. C. Jordan	K. G. McKay
D. E. Noble	K. G. McKay	K. G. McKay	D. E. Noble
J. M. Pettit	D. E. Noble	D. E. Noble	J. M. Pettit
W. H. Pickering	J. M. Pettit	J. M. Pettit	W. H. Pickering
R. J. Potter	W. H. Pickering	W. H. Pickering	R. J. Potter
A. E. Puckett	R. J. Potter	R. J. Potter	A. E. Puckett
G. E. Solomon	A. E. Puckett	A. E. Puckett	L. D. Smullin
E. Weber	S. H. Reiger	S. H. Reiger	G. E. Solomon
	G. E. Solomon	G. E. Solomon	E. Weber
	E. Weber	E. Weber	

COMMITTEE ON TELECOMMUNICATIONS (Continued)

1971 - 1972	1972 - 1973	1973 - 1974	1974 - 1975
W. L. Everitt, Chmn.	W. L. Everitt, Chmn.	H. G. Busignies, Chmn.	H. G. Busignies, Chmn.
R. Adler	R. Adler	R. M. Alden	R. M. Alden
H. G. Busignies	S. L. Bailey	J. A. Baird	S. L. Bailey
R. P. Gifford	G. H. Brown	S. L. Bailey	J. A. Baird
R. A. Henle	H. G. Busignies	E. A. Berg	E. A. Berg
J. Hillier	L. L. Davenport	G. H. Brown	G. H. Brown
E. C. Jordan	R. P. Gifford	L. L. Davenport	L. L. Davenport
K. G. McKay	P. C. Goldmark	L. Ellis	L. W. Ellis
D. E. Noble	G. Heningburg	W. L. Everitt	W. L. Everitt
J. M. Pettit	R. A. Henle	R. M. Fano	R. M. Fano
W. H. Pickering	W. H. Huggins	R. P. Gifford	G. Heningburg
R. J. Potter	E. C. Jordan	P. C. Goldmark	W. H. Huggins
A. E. Puckett	K. G. McKay	G. Heningburg	J. G. Linvill
L. D. Smullin	J. M. Pettit	R. A. Henle	S. Metzger
E. Weber	W. H. Pickering	W. H. Huggins	E. Rechtin
	L. D. Smullin	E. C. Jordan	H. M. Trebing
	E. Weber	J. G. Linvill	J. R. Whinnery
		K. G. McKay	
		S. Metzger	
		J. M. Pettit	
		J. R. Whinnery	

115

Established, December 14, 1967.
Transferred to the Assembly of Engineering, July 1, 1974.

COMMITTEE ON TRANSPORTATION

The committee will make recommendations as to how to develop and maintain liaison and working relationships with government and nongovernment communities in the review and assessment of transportation-related engineering objectives and priorities in their interrelationship with the environment; consider and propose methods for best utilizing engineering talent on transportation problems of national importance; and how best to provide a forum to bring scientists, engineers and other relevant disciplines together for thoughtful discussion and surveys of problems, implications, and opportunities in transportation endeavors.

1969 - 1970

S. W. Herwald, Chmn.
K. W. Bauer
D. S. Berry
R. L. Bisplinghoff
A. S. Boyd
J. H. Hollomon
R. Horonjeff
S. Z. Klausner
A. S. Lang
O. J. Marzke
E. J. O'Donnell
J. P. Romualdi
W. M. Spreitzer
E. C. Wells
C. Zwick

1970 - 1971

S. W. Herwald, Chmn.
K. W. Bauer
D. S. Berry
R. L. Bisplinghoff
J. H. Hollomon
R. Horonjeff
S. Z. Klausner
A. S. Lang
O. J. Marzke
E. J. O'Donnell
R. P. Romualdi
W. M. Spreitzer
E. C. Wells
C. Zwick

1971 - 1972

S. W. Herwald, Chmn.
K. W. Bauer
D. S. Berry
R. L. Bisplinghoff
W. L. Garrison
J. H. Hollomon
R. Horonjeff
J. E. Jonsson
S. Z. Klausner
J. R. Kiely
A. S. Lang
O. J. Marzke
E. J. O'Donnell
W. Owen
J. P. Romualdi
W. C. Smith
W. M. Spreitzer
E. C. Wells
C. Zwick

COMMITTEE ON TRANSPORTATION (Continued)

1972 - 1973	1973 - 1974	1974 - 1975
S. W. Herwald, Chmn.	S. W. Herwald, Chmn.	S. W. Herwald, Chmn.
K. W. Bauer	K. W. Bauer	K. W. Bauer
D. S. Berry	D. S. Berry	D. S. Berry
W. L. Garrison	J. H. Hollomon	R. L. Bisplinghoff
J. H. Hollomon	R. Horonjeff	F. H. Clauser
R. Horonjeff	J. E. Jonsson	W. L. Garrison
J. E. Jonsson	J. R. Kiely	L. R. Hafstad
J. R. Kiely	S. Z. Klausner	J. H. Hollomon
S. Z. Klausner	A. S. Lang	R. Horonjeff
A. S. Lang	O. J. Marzke	J. E. Jonsson
O. J. Marzke	E. J. O'Donnell	J. R. Kiely
E. J. O'Donnell	W. Owen	S. Z. Klausner
W. Owen	J. P. Romualdi	A. S. Lang
J. P. Romualdi	W. S. Smith	O. J. Marzke
W. S. Smith	W. M. Spreitzer	E. J. O'Donnell
W. M. Spreitzer	E. C. Wells	W. Owen
E. C. Wells	C. Zwick	J. P. Romualdi
C. Zwick		W. S. Smith
		W. M. Spreitzer
		J. G. Truxal
		E. C. Wells
		C. Zwick

117

Established, February 6, 1970.
Transferred to the Assembly of Engineering, July 1, 1974.

VOICE OF AMERICA COMMITTEE

The committee shall prepare a proposal on "The World of the Engineer" in cooperation with the staff of the Forum of the Voice of America and the staff of the Office of Information of the Academies of Sciences and Engineering.

1965 - 1968

K. L. Fetters, Chmn.
R. Bainer
A. C. Monteith
J. B. Skilling
J. G. Truxal

Established, October 20, 1965.
Discharged, July, 1968.

APPENDIX V

JOINT ACTIVITIES
of the
National Academy of Engineering
(December, 1964 - December, 1974)

The committees and boards listed in this appendix comprise those advisory activities which were administered jointly by the NAE with the NAS and/or the NRC prior to the promulgation of the "Statement of Principles Underlying Joint Operation of the NRC by the NAS and NAE" on July 1, 1974. Administrative responsibility therefore is indicated by the abbreviations "NAS", "NAE", "NRC" beside committee titles.

Primary sources used in compiling the material herein were: Annual Reports to the Congress for the Academy of Sciences corporation (fiscal years 1964 - 1975); Organization and Members books covering the committee structure of the various elements comprising the NAS corporation (1964 - 1975); and minutes of meetings of the NAE Council and its Executive Committee for the same period. Committee reports were referred to also for pertinent information. Additionally, the rosters of those committees and boards which have been transferred to the Assemblies and Commissions of the NRC and are still in operation were verified by the respective staff officers. Exact dates of establishment, discharge, or transfer are shown where possible.

COMMITTEE ON AMBULANCE DESIGN CRITERIA (NAS/NAE/NRC)

The objectives of the committee shall be to determine and document performance and design criteria for an ambulance vehicle in sufficient detail that automotive designers can produce a vehicle suitable not only to present day practices, but also with adequate provision for future advances in equipment and administration of emergency care.

1968 - 1969

J. E. Baerwald, Chmn.
A. E. Brehm
J. D. Farrington
R. O. Hale
M. J. Herbert
R. C. Hopkins
K. F. Kimball
R. F. McLean
M. C. McMahon
H. B. Parker
P. Safar
R. A. Sarotte
D. H. Slayback
H. R. Snyder
R. J. Sigafoo

Established, September, 1968.
Discharged, June, 1969.

COMMITTEE FOR THE DEVELOPMENT OF CRITERIA FOR NONRAIL TRANSIT VEHICLES (NAE/NRC)

The committee shall identify the criteria to be used in the design of better vehicles for use in providing public transportation in urban areas. The study will include consideration of the overall urban transportation systems in which such vehicles would operate.

1966 - 1967

D. S. Berry, Chmn.
B. Alexander
M. Blumenthal
W. L. Garrison
L. R. Hafstad
E. H. Heinemann
J. R. Meyer
J. K. Mladinov
H. M. Parson
R. L. Sommerville
E. G. Wetzel

1967 - 1968

D. S. Berry, Chmn.
B. Alexander
M. Blumenthal
W. L. Garrison
L. R. Hafstad
E. H. Heinemann
J. R. Meyer

Established March, 1967.
Discharged 1968.

ADVISORY COMMITTEE TO THE DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT (NAS/NAE)

The committee shall advise on establishing acceptability of new or innovative systems, components, materials, and techniques, which may be proposed to meet the objectives of the 1968 Housing Act including advice on experiments and pilot programs necessary or desirable in the development of the full-scale program contemplated by the Act, the identification of needed research and assistance in planning and conducting information services and programs that will encourage professional, industrial, and other groups to participate in the program.

1969 - 1970	1970 - 1971	1971 - 1972	1972 - 1973
B. A. Schriever, Chmn.	G. C. McGhee, Chmn.	G. C. McGhee, Chmn.	G. C. McGhee, Chmn.
A. V. Astin	A. V. Astin	A. V. Astin	W. Alonso
W. L. Cisler	W. L. Cisler	W. L. Cisler	A. V. Astin
T. K. Glennan	T. K. Glennan	T. K. Glennan	A. Chayes
A. Hawley	A. H. Hawley	A. H. Hawley	W. L. Cisler
W. R. Hibbard, Jr.	W. R. Hibbard, Jr.	W. R. Hibbard, Jr.	J. F. Collins
T. C. Kavanagh	T. C. Kavanagh	T. C. Kavanagh	A. Downs
W. E. Moore	J. H. Newman	P. M. Klutznick	B. Fischer
J. H. Newman	V. H. Palmieri	R. D. Nasher	B. Gifford
V. H. Palmieri	S. H. Ruttenberg	J. H. Newman	T. K. Glennan
S. Ramo	B. A. Schriever	K. D. Nichols	A. H. Hawley
S. H. Ruttenberg	J. N. Thompson	V. H. Palmieri	T. C. Kavanagh
F. A. Thomas	J. W. Tukey	J. W. Rouse	P. M. Klutznick
J. W. Tukey	R. C. Wood	B. A. Schriever	R. D. Nasher
		A. Spilhaus	J. H. Newman
		J. N. Thompson	K. D. Nichols
		J. W. Tukey	J. W. Rouse
		R. C. Wood	B. A. Schriever
			A. Spilhaus
			J. N. Thompson
			J. E. Wood, Jr.
			R. C. Wood

Established, 1969.
Discharged, 1973.

U.S. NATIONAL COMMITTEE ON ENGINEERING IN MEDICINE AND BIOLOGY* (NAE/NRC)

The committee shall explore means to enable engineers of the United States in the fields of medicine and biology to participate in the activities of international organizations, such as the International Federation for Medical and Biological Engineering (IFMBE) through the National Academy of Engineering-National Research Council, the body adherent to IFMBE on behalf of the United States; to facilitate cooperation among societies in the United States that represent the interests of engineering in medicine and biology; to perform in the United States the functions of a national committee as described in the Statutes of IFMBE; and to advise the President of the National Academy of Engineering on matters relating to international relations in the field of engineering in medicine and biology.

1965 - 1966, 1966 - 1967	1967 - 1968	1968 - 1969
M. Eden, Chmn.	M. Eden, Chmn.	M. Eden, Chmn.
E. F. Leonard, V. Chmn.	E. F. Leonard, V. Chmn.	E. F. Leonard, V. Chmn.
R. E. DeForest	R. E. DeForest	L. W. Bluemle, Jr.
L. Fox	L. Fox	R. L. Bowman
J. Lyman	A. S. Gates, Jr.	R. E. DeForest
J. W. Moore	J. Lyman	D. D. Flickinger
H. W. Shipton	J. W. Moore	L. Fox
L. Slote	H. W. Shipton	A. S. Gates, Jr.
S. A. Wesolowski	L. Slote	J. Lyman
	S. Wesolowski	E. F. Murphy
		J. R. Platt
		H. W. Shipton
		L. Slote
		S. A. Wesolowski

*Cf. Ad Hoc Committee to Determine the Feasibility of Providing Advisory Services in the Field of Engineering in Medicine and Biology, Page 96; Committee on the Interplay of Engineering with Biology and Medicine, Page 99; Ad Hoc Committee to Review the Need for Activities in the National Academy of Engineering in Medicine and Biology, Page 107.

Established, June 24, 1966.
Discharged, 1969.

ENVIRONMENTAL STUDIES BOARD (NAS/NAE)

Initiates, conducts, coordinates, and reviews studies in the area of environmental quality and natural resource management. Responds to requests for advice from government agencies and other decision-making or policy-setting institutions by arranging multidisciplinary advisory panels or through work of its own membership. Analyzes society's conflicting demands on environmental values and seeks an optimum balance between immediate economic gain and long-term continued productivity and aesthetic quality. Sustained through a grant from the Scaife Family Charitable Trusts.

1966 - 1967

H. Gershincwitz, Chmn.
W. L. Chadwick
F. A. L. Holloway
R. Morison
J. Perkins
R. Revelle
C. Starr

1967 - 1968

H. Gershinowitz, Chmn.
H. W. Bode
W. L. Chadwick
F. A. L. Holloway
R. Morison
H. S. Perloff
R. Revelle
C. Starr

1968 - 1969

H. Gershinowitz, Chmn.
H. W. Bode
W. L. Chadwick
F. A. L. Holloway
G. E. Hutchinson
R. Morison
H. S. Perloff
R. Revelle
C. Starr

1969 - 1970

H. Gershinowitz, Chmn.
H. W. Bode
W. L. Chadwick
G. E. Hutchinson
R. Morison
R. Revelle
C. Starr

1970 - 1971

D. M. Gates, Chmn.
W. C. Ackermann
H. W. Bode
R. A. Bryson
H. Gershinowitz
A. D. Hasler
G. E. Hutchinson
T. F. Malone
R. S. Morison
R. Revelle
J. L. Sax
C. Starr
J. A. Swartout

1971 - 1972

D. M. Gates, Chmn.
W. C. Ackermann
H. W. Bode
R. A. Bryson
A. D. Hasler
G. E. Hutchinson
T. F. Malone
R. S. Morison
R. Revelle
J. L. Sax
C. Starr
J. A. Swartout

ENVIRONMENTAL STUDIES BOARD (Continued)

1972 - 1973	1973 - 1974	1974 - 1975
G. J. F. MacDonald, Chmn.	H. W. Johnson, Chmn.	H. W. Johnson, Chmn.
W. C. Ackermann	N. H. Brooks	N. H. Brooks
H. W. Bode	J. N. Brownell	J. N. Brownell
R. A. Bryson	L. K. Caldwell	L. K. Caldwell
D. M. Gates	W. T. Edmondson	W. J. Coppoc
A. D. Hasler	J. A. Fay	R. Dorfman
T. F. Malone	A. D. Hasler	W. T. Edmondson
R. S. Morison	T. F. Malone	J. A. Fay
R. Revelle	R. S. Morison	D. C. McGrath
J. L. Sax	R. Revelle	N. Nelson
C. Starr	J. A. Swartout	D. Reichle
J. A. Swartout	N. Wollman	N. Wollman
		M. G. Wolman

125

Established, January, 1967.
Transferred to the Commission on Natural Resources, October, 1974.

COMMITTEE ON MEDICAL AND BIOLOGIC EFFECTS OF ENVIRONMENTAL POLLUTANTS* (NAE/NRC)

Reviews and evaluates currently available data of the effects of atmospheric contaminants on human health and welfare; identifies key problem areas in which further research is needed.

1968 - 1969, 1969 - 1970	1970 - 1971	1971 - 1972
A. B. Dubois, Chmn.	A. B. Dubois, Chmn.	A. B. Dubois, Chmn.
R. R. Beard	V. W. Bacon	D. M. Anderson
B. D. Dinman	A. M. Baetjer	V. W. Bacon
L. E. Farhi	W. C. Cooper	A. M. Baetjer
R. E. Forster	M. Corn	R. J. Byerrum
J. R. Goldsmith	B. D. Dinman	W. C. Cooper
V. G. Laties	L. Golberg	P. B. Hammond
S. Permutt	P. B. Hammond	S. P. Hicks
J. H. Schulte	S. P. Hicks	J. Lieben
	V. G. Laties	P. Meier
	A. M. Lilienfeld	J. N. Pitts, Jr.
	P. Meier	G. J. Stopps
	J. N. Pitts, Jr.	F. W. Sunderman, Jr.
	G. J. Stopps	B. L. Van Duuren
	O. C. Taylor	J. J. Vostal
	J. J. Vostal	B. Weiss

126

* Established as the Committee on Effects of Atmospheric Contaminants on Human Health and Welfare. As its scope was enlarged, the committee was reorganized, expanded, and renamed, first as the Committee on Biologic Effects of Atmospheric Pollutants (May 2, 1970) and later as the Committee on Medical and Biologic Effects of Environmental Pollutants (October 8, 1973), its present title.

COMMITTEE ON MEDICAL AND BIOLOGIC EFFECTS OF ENVIRONMENTAL POLLUTANTS (Continued)

1972 - 1973	1973 - 1974	1974 - 1975
H. E. Griffin, Chmn.	H. E. Griffin, Chmn.	H. E. Griffin, Chmn.
W. H. Allaway	D. M. Anderson	R. F. Coburn
D. M. Anderson	R. U. Byerrum	T. T. Crocker
V. W. Bacon	R. F. Coburn	S. K. Friedlander
A. M. Baetjer	T. T. Crocker	S. A. Gunn
R. U. Byerrum	S. K. Friedlander	R. I. Henkin
W. C. Cooper	S. A. Gunn	I. T. T. Higgins
R. I. Henkin	R. I. Henkin	J. W. Hightower
S. P. Hicks	I. T. T. Higgins	O. A. Levander
I. T. T. Higgins	J. W. Hightower	D. F. Metzler
J. Lieben	O. A. Levander	I. H. Scheinberg
J. N. Pitts, Jr.	D. F. Metzler	R. G. Smith
I. H. Scheinberg	I. H. Scheinberg	F. W. Sunderman, Jr.
R. G. Smith	R. G. Smith	B. L. Van Duuren
G. J. Stopps	G. J. Stopps	
F. W. Sunderman, Jr.	F. W. Sunderman, Jr.	
B. L. Van Duuren	B. L. Van Duuren	
J. J. Vostal	B. Weiss	
B. Weiss		

127

Established, July, 1968.
Transferred to the Assembly of Life Sciences, July 1, 1974.

COMMITTEE ON MINERAL SCIENCE AND TECHNOLOGY (NAS/NAE/NRC)

Established to survey the status of minerals- and fuels-related science and technology in order to develop advice as to actions that should be taken by the Bureau of Mines to support and increase the vitality of mineral science and technology. University research and educational training in mineral science and technology and the means of increasing interest therein will receive particular attention and emphasis.

128

1966 - 1967

E. F. Osborn, Chmn.
J. Boyd
J. C. Calhoun, Jr.
J. F. Core
G. J. Derge
M. A. Elliot
K. L. Fetters
J. C. Frye
M. D. Hassialis
G. R. Hill
D. L. Katz
G. J. F. MacDonald
D. C. Minton, Jr.
J. D. Morgan, Jr.
C. E. Reistle
R. Roy
W. W. Rubey

1967 - 1968, 1968-1969

E. F. Osborn, Chmn.
J. Boyd
J. C. Calhoun, Jr.
G. J. Derge
M. A. Elliot
K. L. Fetters
J. C. Frye
M. D. Hassialis
G. R. Hill
D. L. Katz
G. J. F. MacDonald
D. C. Minton, Jr.
J. D. Morgan, Jr.
J. J. Reed
C. E. Reistle
R. Roy
W. W. Rubey

Established, July 29, 1966.
Discharged, 1969.

PANELS FOR THE EVALUATION OF NATIONAL BUREAU OF STANDARDS PROGRAMS AND ACTIVITIES
(NAS/NAE/NRC)

Established to review and evaluate the research, development, and technical service activities of the Bureau. Panel members are selected from among the leaders in the fields of research and administration in industry, government, and universities. There are about thirty panels, one for each of the major organizational units and, in addition, one for each of the technical divisions within the Bureau. Guidance and oversight are provided by an Executive Committee,* the membership of which is listed below.

1969 - 1970

W. O. Baker, Chmn.
W. G. Amey
J. A. Hornbeck
W. P. Slichter
M. Witunski
M. R. Cleland
J. Moshman

1970 - 1971

W. O. Baker, Chmn.
J. A. Hornbeck
W. G. Amey
W. P. Slichter
M. Witunski
W. H. Zinn
J. Moshman

1971 - 1972

W. O. Baker, Chmn.
W. G. Amey
B. Augenstein
A. M. Bueche
H. C. Gatos
N. B. Hannay
W. R. Hibbard, Jr.
J. A. Hornbeck
M. Witunski

1972 - 1973

W. O. Baker, Chmn.
W. G. Amey
B. Augenstein
R. A. Bauer
A. M. Bueche
H. C. Gatos
N. B. Hannay
W. R. Hibbard, Jr.
J. A. Hornbeck
M. Witunski

1973 - 1974

W. O. Baker, Chmn.
B. Augenstein
R. A. Bauer
A. M. Bueche
H. C. Gatos
N. B. Hannay
W. R. Hibbard, Jr.
R. W. Schmitt
I. C. Schoonover
M. Witunski

1974 - 1975

W. O. Baker, Chmn.
J. J. Baruch
R. A. Bauer
H. C. Gatos
M. Harris
A. K. McAdams
C. J. Meechan
R. W. Schmitt
I. C. Schoonover
G. K. Walters
M. Witunski

* The Executive Committee for the project was first organized in 1969. The panels were transferred to the Assembly of Mathematical and Physical Sciences, NRC, July 1, 1974.

SCIENCE AND ENGINEERING COMMITTEE ADVISORY TO THE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA)* (NAS/NAE/NRC)

Established to advise those elements of the National Oceanic and Atmospheric Administration (NOAA) which were previously the Environmental Science Services Administration, on their scientific, engineering, and services programs.

1966 - 1967	1967 - 1968	1968 - 1969
V. E. Suomi, Chmn.	V. E. Suomi, Chmn.	V. E. Suomi, Chmn.
W. C. Ackermann	W. C. Ackermann, V. Chmn.	W. C. Ackermann, V. Chmn.
L. J. Battan	B. A. Bolt	B. A. Bolt
B. A. Bolt	H. G. Booker	H. G. Booker
F. H. Clauser	F. H. Clauser	F. H. Clauser
R. W. Clough	R. W. Clough	R. W. Clough
C. S. Draper	C. S. Draper	C. L. Drake
M. Ference, Jr.	J. E. Haas	C. S. Draper
J. E. Haas	S. I. Hammer	J. E. Haas
S. I. Hammer	W. V. Hurley	S. I. Hammer
W. V. Hurley	J. D. Isaacs	W. V. Hurley
J. D. Isaacs	F. S. Johnson	J. D. Isaacs
F. S. Johnson	W. M. Kaula	F. S. Johnson
W. M. Kaula	A. V. Kneese	W. M. Kaula
A. V. Kneese	C. E. Leith, Jr.	A. V. Kneese
C. E. Leith, Jr.	W. H. Munk	C. E. Leith, Jr.
W. H. Munk	H. Rouse	W. H. Munk
H. Rouse	M. A. Tuve**	H. Rouse
	H. K. Work**	W. von Arx
	W. V. Wright**	M. A. Tuve**
		J. W. Mulligan, Jr.**

130

* Formerly Committee Advisory to the Environmental Services Administration.
** Ex officio

SCIENCE AND ENGINEERING COMMITTEE ADVISORY TO THE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA) (Continued)

1969 - 1970	1970 - 1971, 1971 - 1972	1972 - 1973
V. E. Suomi, Chmn.	C. L. Drake, Chmn.	C. L. Drake, Chmn.
W. C. Ackermann	W. C. Ackermann	S. Atwood
B. A. Bolt	B. A. Bolt	L. J. Battan
H. G. Booker	H. G. Booker	J. N. Brune
F. H. Clauser	J. N. Brune	W. J. Hargis
R. W. Clough	C. S. Draper	J. R. Heirtzler
C. L. Drake	J. E. Haas	C. L. Hosler
C. S. Draper	J. R. Heirtzler	W. V. Hurley
J. E. Haas	W. V. Hurley	C. P. Idyll
E. I. Hammer	F. S. Johnson	A. V. Kneese
W. V. Hurley	W. M. Kaula	C. E. Leith, Jr.
J. D. Isaacs	A. V. Kneese	R. K. Linsley
F. S. Johnson	C. E. Leith, Jr.	E. N. Lorenz
W. M. Kaula	N. M. Newmark	N. M. Newmark
A. V. Kneese	D. J. O'Connor	D. J. O'Connor
C. E. Leith, Jr.	R. J. Reed	G. Pontecorvo
W. H. Munk	V. E. Suomi	R. J. Reed
H. Rouse	W. S. von Arx	J. Ryther
W. S. von Arx	E. Wenk, Jr.	H. E. Sheets
M. A. Tuve**	A. D. Wheelon	J. W. Tukey
J. H. Mulligan, Jr.**	M. A. Tuve**	W. S. von Arx
J. W. Berg, Jr.**	J. H. Mulligan, Jr.**	G. C. Weiffenbach
G. J. F. MacDonald**		E. Wenk, Jr.
		A. D. Wheelon

** Ex offico

Established, November, 1966.
Discharged, June, 1973.

COMMITTEE ON NATURAL DISASTERS* (NAS/NAE/NRC)

The committee shall form and dispatch teams to investigate episodes of engineering design and structural interest as soon as possible following a disaster brought about by, for example, earthquakes, winds, tsunamis, floods, and possibly conflagrations, and publish a report on each site visit.

1965 - 1966

G. W. Housner, Chmn.
G. V. Berg
R. W. Clough
D. E. Hudson
N. M. Newmark
R. B. Peck
J. Rinne
R. F. Scott
H. B. Seed
J. B. Skilling
R. L. Wiegel

1966 - 1967

G. W. Housner, Chmn.
G. V. Berg
R. W. Clough
D. E. Hudson
J. C. Monning
N. M. Newmark
R. B. Peck
J. Rinne
R. F. Scott
H. B. Seed
J. B. Skilling
R. L. Wiegel

1967 - 1970

G. W. Housner, Chmn.
G. V. Berg
R. W. Clough
D. E. Hudson
N. M. Newmark
R. B. Peck
J. Rinne
R. F. Scott
H. B. Seed
J. B. Skilling
R. L. Wiegel
S. D. Wilson

1970 - 1971

R. W. Clough, Chmn.
G. W. Housner
N. M. Newmark

1971 - 1974

R. W. Clough, Chmn.
A. G. Davenport
J. E. Cermak
G. W. Housner
N. M. Newmark

* Established as the Committee on Earthquake Engineering Research; designated as the Committee on Earthquake Inspection in spring, 1970, and as the Committee on Inspection of Structural Damage Due to Earthquakes, Winds, and Other Natural Disasters in May, 1970. The committee was given its present title in June, 1971.

Established, September 23, 1965.
Transferred to the Commission on Sociotechnical Systems, NRC, July 1, 1974.

COMMITTEE ON THE NORTH AMERICAN DATUM (NAS/NAE/NRC)

Established to determine if the benefits resulting from a readjustment of the North American geodetic triangulation network would be commensurate with the costs.

1968 - 1969	1969 - 1970	1970 - 1971
P. A. Smith, Chmn.	P. A. Smith, Chmn.	P. A. Smith, Chmn.
R. M. Berry	R. M. Berry	R. M. Berry
G. H. Clement	G. H. Clement	G. H. Clement
C. H. Frey	C. H. Frey	C. H. Frey
F. T. Moore	M. O. Laird	M. O. Laird
L. G. Simmons	F. T. Moore	F. T. Moore
U. A. Uotila	J. C. Reed	J. C. Reed
	L. G. Simmons	L. G. Simmons
	U. A. Uotila	U. A. Uotila
	J. W. Berg, Jr.*	
	G. J. F. MacDonald*	

133

* Ex offico

Established, fall, 1968.
Discharged, 1971.

COMMITTEES ON POLLUTION ABATEMENT AND CONTROL (NAS/NAE/NRC)

The Committees on Solid Waste Management, Air Quality Management, Water Quality Management, and Noise study and advise on engineering aspects and general problems of pollution abatement and control and undertake specific related studies as may be authorized and funded.

Committee on Solid Waste Management

1968 - 1969

D. N. Frey, Chmn.
F. R. Bowman
D. J. Damiano
S. A. Hart
P. H. McGauhey

1969 - 1975

D. N. Frey, Chmn.
H. W. Bode
F. R. Bowerman
D. J. Damiano
S. A. Hart
P. H. McGauhey
L. Weaver

Committee on Water Quality Management

1968 - 1969

E. J. Cleary, Chmn.
J. F. Byrd
J. B. Coulter
G. M. Fair
M. D. Hollis
R. A. Fanderhoof

1969 - 1970, 1970 - 1971

E. J. Cleary, Chmn.
G. M. Fair, V. Chmn.
J. F. Byrd
J. B. Coulter
M. D. Hollis
J. A. Logan

1971 - 1975

E. J. Cleary, Chmn.
J. F. Byrd
J. B. Coulter
M. D. Hollis
J. A. Logan

COMMITTEES ON POLLUTION ABATEMENT AND CONTROL (Continued)

Committee on Air Quality Management

1968 - 1969

T. K. Sherwood, Chmn.
T. H. Chilton
M. R. Fenske
R. L. Hershey

1969 - 1970

T. K. Sherwood, Chmn.
T. H. Chilton
M. R. Fenske
R. L. Hershey
C. G. Kirkbride

1970 - 1971, 1971 - 1972

J. E. McKee, Chmn.
R. Bryson*
T. H. Chilton
M. R. Fenske
S. K. Friedlander
R. L. Hershey
C. G. Kirkbride
C. N. Satterfield
T. K. Sherwood

1972 - 1973, 1973 - 1974

J. J. McKetta, Jr., Chmn.
R. Bryson*
T. H. Chilton
S. K. Friedlander
R. L. Hershey
C. G. Kirkbride
C. N. Satterfield

1974 - 1975

J. J. McKetta, Jr., Chmn.
R. Bryson*
S. K. Friedlander
C. G. Kirkbride
C. N. Satterfield

Committee on Noise**

1968 - 1974

L. N. Miller, Chmn.

* Ex officio

The committees were established December 14, 1967.
Transferred to the Commission on Sociotechnical Systems, NRC, July 1, 1974.
** Discharged, July 1, 1974.

COMMITTEE ON RADIO FREQUENCIES* (NAS/NAE)

Established to consider the needs for radio frequency requirements for scientific and engineering research, coordinate the views of the U.S. scientists, and act as the channel for representing the interests of U.S. scientists in the work of the Inter-Union Committee on Frequency Allocations for Radio Astronomy and Space Science of the International Council of Scientific Unions.

1965 - 1966

E. M. Webster, Chmn.
A. Barnabei
B. F. Burke
R. J. Coates
R. M. Emberson
J. P. Hagen
E. H. Hurlburt
R. S. Lawrence
A. E. Lilley
E. F. McClain
G. C. McVittie
J. M. Snodgrass
G. W. Swenson, Jr.
H. W. Trotter, Jr.
O. G. Villard, Jr.

1966 - 1967, 1967 - 1968

E. M. Webster, Chmn.
A. Barnabei
B. F. Burke
R. J. Coates
R. M. Emberson
J. P. Hagen
E. H. Hurlburt
R. S. Lawrence
A. E. Lilley
E. F. McClain
G. C. McVittie
P. A. Price
J. M. Snodgrass
G. W. Swenson, Jr.
H. W. Trotter, Jr.
O. G. Villard, Jr.

* Formerly the Committee on Radio Frequency Requirements for Scientific Research.

COMMITTEE ON RADIO FREQUENCIES (Continued)

1968 - 1969

T. K. Glennan, Chmn.
A. Barnabei
B. F. Burke
R. J. Coates
R. M. Emberson
J. P. Hagen
E. H. Hurlburt
R. S. Lawrence
A. E. Lilley
E. F. McClain
G. C. McVittie
P. A. Price
J. M. Snodgrass
G. W. Swenson, Jr.
H. W. Trotter, Jr.
O. G. Villard, Jr.

1969 - 1970

T. K. Glennan, Chmn.
H. A. Baldwin
M. T. Decker
R. M. Emberson
J. W. Findlay
J. P. Hagen
W. E. Howard III
R. S. Lawrence
P. A. Price
A. H. Shapley
J. M. Snodgrass
G. W. Swenson, Jr.

1970 - 1971

J. W. Findlay, Chmn.
H. A. Baldwin
M. T. Decker
R. M. Emberson
J. L. Greenstein
J. P. Hagen
W. E. Howard III
R. S. Lawrence
P. A. Price
A. H. Shapley
J. M. Snodgrass
G. W. Swenson, Jr.

1971 - 1972

J. W. Findlay, Chmn.
H. A. Baldwin
M. T. Decker
R. M. Emberson
J. L. Greenstein
J. P. Hagen
W. E. Howard III
R. S. Lawrence
P. A. Price
A. H. Shapley
J. M. Snodgrass
G. W. Swenson, Jr.

1972 - 1973

J. W. Findlay, Chmn.
H. A. Baldwin
M. T. Decker
R. M. Emberson
J. P. Hagen
W. E. Howard III
R. S. Lawrence
P. A. Price
J. M. Snodgrass
Y. Terzian
G. Westerhout

1973 - 1974, 1974 - 1975

B. F. Burke, Chmn.
H. A. Baldwin
M. T. Decker
W. C. Erickson
J. P. Hagen
W. E. Howard III
P. A. Price
J. M. Snodgrass
Y. Terzian
G. Westerhout

Established in 1961 as a committee of the NAS; designated a joint NAS/NAE committee in October, 1969.
Transferred to the Assembly of Mathematical and Physical Sciences, NRC, July 1, 1974.

COMMITTEE ON RAPID EXCAVATION TECHNIQUES (NAS/NAE/NRC)

The committee shall examine the importance of improving rapid excavation capability; explore the scope and adequacy of present research activity; identify areas of research and development requiring greater emphasis; and provide recommendations for a general research program commensurate with rapid excavation problems and needs.

1966 - 1967, 1967 - 1968

E. P. Pfleider, Chmn.
T. F. Adams
B. P. Bellport
J. D. Bledsoe
K. C. Cox
D. U. Deere
W. S. Douglas
H. L. Hartman
J. D. Jacobs
E. A. Jones
K. S. Lane
W. C. Maurer
R. B. McNee
R. T. Newcomb
L. Obert
L. B. Underwood
P. R. Vandersloot
T. N. Williamson
J. R. Meyer

Established, September 9, 1966.
Discharged, 1968.

U.S. NATIONAL COMMITTEE FOR ROCK MECHANICS (NAS/NAE)

Serves as U.S. adherent to the International Society for Rock Mechanics and acts to promote U.S. interests in the science and engineering of rock mechanics domestically and internationally.

1966 - 1967	1967 - 1968	1968 - 1969	1969 - 1970
W. R. Judd, Chmn.	W. R. Judd, Chmn.	W. R. Judd, Chmn.	J. W. Handin, Chmn.
R. F. Beers	K. E. Gray	J. R. Borchert*	K. E. Gray, V. Chmn.
J. B. Cheatham, Jr.	J. W. Handin	H. Brown*	H. Brown*
W. I. Duvall	G. H. Higgins	D. C. Drucker	D. C. Drucker
N. Grosvenor	L. B. James	W. I. Gardner	C. Fairhurst
J. W. Handin	K. S. Lane	K. W. Gray	R. E. Goodman
D. O. Rausch	G. A. Leonards	J. W. Handin	H. C. Heard
E. C. Robertson	R. D. Mindlin	G. H. Higgins	J. A. Hutcheson*
	L. A. Panek	J. A. Hutcheson*	O. A. Israelsen
	E. C. Robertson	O. A. Israelsen	W. R. Judd
	W. H. Wolf	L. B. James	G. A. Leonards
		K. S. Lane	G. J. F. MacDonald*
		G. A. Leonards	W. C. Maurer
		L. A. Panek	L. A. Obert
		C. B. Raleigh	C. B. Raleigh
		E. C. Robertson	G. B. Wallace

* Ex officio

1970 - 1971	1971 - 1972	1972 - 1973	1973 - 1974
J. W. Handin, Chmn.	J. W. Handin, Chmn.	C. Fairhurst, Chmn.	C. Fairhurst, Chmn.
K. E. Gray, V. Chmn.	K. E. Gray, V. Chmn.	G. B. Wallace, V. Chmn.	G. B. Wallace, V. Chmn.
E. J. Deklotz	W. F. Brace	J. F. T. Agapito	J. F. T. Agapito
D. C. Drucker	W. S. Brown	W. F. Brace	W. F. Brace
C. Fairhurst	G. B. Clark	W. S. Brown	W. S. Brown
R. E. Goodman	E. J. Deklotz	G. B. Clark	G. B. Clark
H. C. Heard	C. Fairhurst	R. A. Cunningham	R. A. Cunningham
O. A. Israelsen	H. C. Heard	E. J. Deklotz	H. C. Heard
W. R. Judd	O. A. Israelsen	H. C. Heard	E. R. Hoskins
K. S. Lane	W. N. Lucke	E. R. Hoskins	C. B. Raleigh
W. C. Maurer	D. L. Misterek	W. N. Lucke	G. B. Rupert
L. A. Obert	L. A. Panek	D. L. Misterek	H. Sutcliffe
L. A. Panek	C. B. Raleigh	C. B. Raleigh	H. Brown*
C. B. Raleigh	R. E. Riecker	R. E. Riecker	C. L. Drake*
R. E. Riecker	G. B. Rupert	G. B. Rupert	L. A. Obert*
G. B. Rupert	D. T. Snow	D. T. Snow	E. Weber*
G. B. Wallace	G. B. Wallace	H. Sutcliffe	
	H. Brown*	H. Brown*	
	L. A. Obert*	L. A. Obert*	
	E. Weber*	B. S. Old*	
		E. Weber*	

140

1974 - 1975

G. B. Wallace, Chmn.	H. C. Heard
J. F. T. Agapito	E. R. Hoskins
W. F. Brace	C. B. Raleigh
W. S. Brown	G. B. Rupert
G. B. Clark	H. Sutcliffe
R. A. Cunningham	G. S. Hammond*
C. Fairhurst	J. W. Handin*
B. S. Old*	

* Ex officio

Established, February 5, 1967.
Transferred to the Assembly of Mathematical and Physical Sciences, NRC, July 1, 1974.

COMMITTEE ON SCIENCE, ENGINEERING AND REGIONAL DEVELOPMENT (NAS/NAE)

The committee shall undertake a study of the impact of science and engineering on regional development and of the effect of federal scientific and technical policies on regional economic development.

1967 - 1968, 1968 - 1969

D. Albert, Chmn.
G. Black
R. Bcwers
J. Feldmeier
C. C. Furnas
W. Garrison
W. K. Linvill
S. Quigley
G. S. Schairer
A. Shapero
G. Simpson, Jr.
D. Tikker
M. Weidenbaum
R. Widner

Established January 1, 1967.
Discharged, 1969.

COMMITTEE ON SCIENTIFIC AND TECHNICAL COMMUNICATION (NAS/NAE)

The committee shall examine in broad perspective, and make recommendations on, the present status and future requirements of the scientific and engineering community with respect to the flow and transfer of information about research and development plans and programs, and also of the scientific and technical information which these programs produce.

1965 - 1966	1966 - 1967	1967 - 1968	1968 - 1969
R. W. Cairns, Chmn.	R. W. Cairns, Chmn.	R. W. Cairns, Chmn.	R. W. Cairns, Chmn.
R. L. Bisplinghoff	R. L. Bisplinghoff	C. G. Benjamin	J. J. Baruch
C. G. Benjamin	C. G. Benjamin	R. L. Bisplinghoff	R. L. Bisplinghoff
D. I. Cooper	D. I. Cooper	D. I. Cooper	D. Easton
R. L. Engle, Jr.	R. L. Engle, Jr.	R. L. Engle, Jr.	R. L. Engle, Jr.
C. Herring	C. Herring	C. Herring	C. Herring
G. E. Holbrook	G. E. Holbrook	G. E. Holbrook	G. E. Holbrook
J. C. R. Licklider	J. C. R. Licklider	D. L. Katz	D. L. Katz
C. H. Linder	C. H. Linder	J. C. R. Licklider	J. C. R. Licklider
O. T. Marzke	O. T. Marzke	C. H. Linder	C. H. Linder
H. W. Magoun	H. W. Magoun	O. T. Marzke	J. D. Luntz
N. M. Newmark	N. M. Newmark	N. M. Newmark	N. M. Newmark
W. H. Pickering	B. Riegel	B. Riegel	B. Riegel
B. Riegel	W. C. Steere	W. C. Steere	W. C. Steere
W. C. Steere	D. R. Swanson	D. R. Swanson	D. R. Swanson
D. R. Swanson	J. W. Tukey	J. W. Tukey	J. W. Tukey
J. W. Tukey	M. A. Tuve	M. A. Tuve	M. A. Tuve
M. A. Tuve	W. B. Wiley	W. B. Wiley	W. B. Wiley
P. Weiss			
W. B. Wiley			
V. Z. Williams			

Established, March 24, 1965.
Discharged, December 31, 1969.

COMMITTEE ON THE SCIENTIFIC AND TECHNOLOGIC BASE OF PUERTO RICO'S ECONOMY (NAS/NAE/NRC)

Established to undertake a study to identify and outline activities designed to strengthen the scientific and technologic base of Puerto Rico's industrial and general economic development.

1965 - 1966

J. C. Warner, Chmn.
H. R. Beatty
P. Conley
C. H. Fisher
R. W. McNamee
B. S. Old
V. Roterus
J. H. Ryther
H. B. Steinbach
R. Stevens
T. Theis

1966 - 1967

J. C. Warner, Chmn.
H. R. Beatty
H. R. Bullis, Jr.
P. Conley
J. N. Efferson
C. H. Fisher
A. G. Keller
R. W. McNamee
B. S. Old
V. Roterus
J. H. Ryther
H. B. Steinbach
R. Stevens
T. Theis

Established February 1966.
Discharged, 1967.

COMMITTEE ON SOCIAL AND BEHAVIORAL URBAN RESEARCH (NAS/NAE/NRC)

The committee shall advise on the social, economic, and institutional factors which presently define the need for and affect the introduction of new technologies, and which also underlie emerging social needs.

1967 - 1968

R. A. Bauer, Chmn.
E. N. Bacon
B. J. L. Berry
H. E. Brazer
J. C. Bressee
L. H. Day
N. Glazer
A. Hawley
E. S. Lee
N. E. Long
D. R. Mandelker
W. R. Mason
A. M. Weinberg
A. Wolman
P. N. Ylvisaker

Established, August 31, 1967.
Discharged, 1968.

COMMITTEE ON URBAN TECHNOLOGY (NAS/NAE)

The committee shall suggest ways by which new urban technologies could be developed and the energies of American industry addressed to exploring such advances broadly and promptly.

1967 - 1968

J. F. Young, Chmn.
G. M. Amdahl
G. S. Brown
A. A. Campbell
J. H. Dessauer
R. H. Dietz
L. R. Hafstad
W. C. Higdon
N. Keyfitz
T. Y. Lin
R. F. Mettler
R. Newcomb
J. H. Newman

Established, August 31, 1967.
Discharged, 1968.

APPENDIX VI

FINANCIAL ASPECTS OF ACADEMY OPERATIONS

FINANCIAL ASPECTS OF ACADEMY OPERATIONS

The National Academy of Engineering conducts its operations within the framework of the National Academy of Sciences corporate body. These operations comprise activities which are associated primarily with the honorific aspects of the organization, the contractual work of its technical boards and committees, and the overall administrative functions performed by the NAE Executive Office in connection with the foregoing activities and in support of the NAE Council and officers.

The financial aspects of the Academy's operations can be conveniently quantified by three parameters: the NAE Independent Fund balance; the total annual administrative expenses associated with the conduct of its operations; and, the total annual amount of contractual expenditures by the technical units. The Independent Fund balance indicates the status of those NAE financial resources which are directly under the control of the NAE Council. The total annual administrative expenses of the NAE are charged either to the NAE or to the NAS, with the NAE portion being defrayed by Independent Funds. The total annual amount of contractual expenditures is the sum of the expenditures charged directly to contracts by boards and committees (e.g. staff salaries, travel, printing, duplicating, etc.) which were simultaneously in operation in a given fiscal year. Further details concerning the financial aspects of the Academy's operations are presented in the following paragraphs.

NAE Independent Funds consist of dues received from membership and unrestricted contributions from members and other individuals, corporations, and foundations. Such funds are retained in accounts administered by the NAS

corporation.* These funds are used to defray those NAE administrative expenses which relate to the honorific aspects of the organization, as authorized by the NAE Council as line items in each fiscal year's budget. Such expenses include those associated with membership services (e.g. costs of conducting the annual election of new members, printing the annual Directory of Members, etc.), support of Annual and Autumn meetings, and special programs, symposia and other activities approved by the Council and conducted under the auspices of the NAE Executive Office.

In any given year, the change in the Independent Fund balance is the difference between the income received from sources noted above and the total expenses associated with the honorific activities chargeable to Independent Funds. Figure 1 presents the history of the NAE Independent Fund balance through June 30, 1975, the end of fiscal year 1975. The Independent Fund balance is traced for about six months beyond the date of the Academy's Tenth Anniversary, through the end of fiscal year 1975, to display the favorable change which occurred over that interval.

The Independent Fund balance grew from a level of approximately $2,700 in fiscal year 1965 to a peak of approximately $160,000 at the end of fiscal year 1971. The increase of the balance between 1968 and 1971 reflects the results of a fund raising effort led by Academy member Philip Sporn (see page 9). The decline of the balance between 1971 and 1974 was largely due to the expiration of many five-year pledges which were generated by the 1968 campaign. The sharp upswing in the Independent Fund balance starting in fiscal year 1975 was the result of a second major fund raising campaign headed by Academy member Donald N. Frey, Chairman of the Board and President, Bell and Howell Company.

The administrative expenses of the total NAS corporation which are not identifiable with and directly chargeable to specific contractual projects are recovered by the NAS as indirect costs (i.e., overhead) charged as a percentage of all government and private contracts and grants; the funds thus recovered comprise the major

---

* The Academy's total assets also include funds on deposit with the National Academy of Engineering Foundation, an independent non-profit corporation established by the NAE Council in May, 1973. As of December 5, 1974, these funds totaled approximately $56,000.

portion of the NAS General Fund. An allocation is made annually to the NAE from the NAS General Fund on a basis mutually agreed upon by the two Academies. This allocation covers expenditures for all staff salaries and for a portion of administrative and other supporting functions (e.g., travel, printing and duplicating, materials and services, communications, etc.), related to the operation of the NAE Executive Office, including administration of the contracts of the NAE technical boards and committees. Additionally, as part of the corporation, the NAE is provided with such facilities as office space, furniture and equipment, as well as with various other supportive services such as accounting, personnel, and library.

The history of the NAE's total annual administrative expenses (i.e., the sum of the expenditures charged to the indirect cost pool allocation and to NAE Independent Funds) is shown in Figure 2. As this figure indicates, the Academy's administrative expenses increased from a level of approximately $65,000 during its first fiscal year of operation to somewhat over $.5 million in fiscal year 1974. In general, NAE Independent Funds have defrayed approximately one-quarter of the Academy's total annual administrative expenses.

On July 1, 1974, the twelve technical boards and committees then in being under the NAE were transferred into the National Research Council to form the Assembly of Engineering. Until that time, the NAE had full administrative responsibility for the technical units named in Appendix IV, and shared in the administration of the committees identified in Appendix V. All such units were supported primarily under contracts with various agencies of the federal government. Figure 3 presents the history of the total annual amount of expenditures directly associated with the operation of the NAE technical boards and committees.

With the exception of a modest decline in fiscal year 1973, the total annual amount of the Academy's contractual expenditures increased from a level of about $.25 million in fiscal year 1968 to a level of approximately $1.7 million in fiscal year 1974.* The levels of NAE contractual activity were not separately identified in the financial statements of the NAS corporation prior to fiscal year 1968, and consequently are not shown in Figure 3.

---

*Contractual expenditures of joint committees are excluded from these figures.

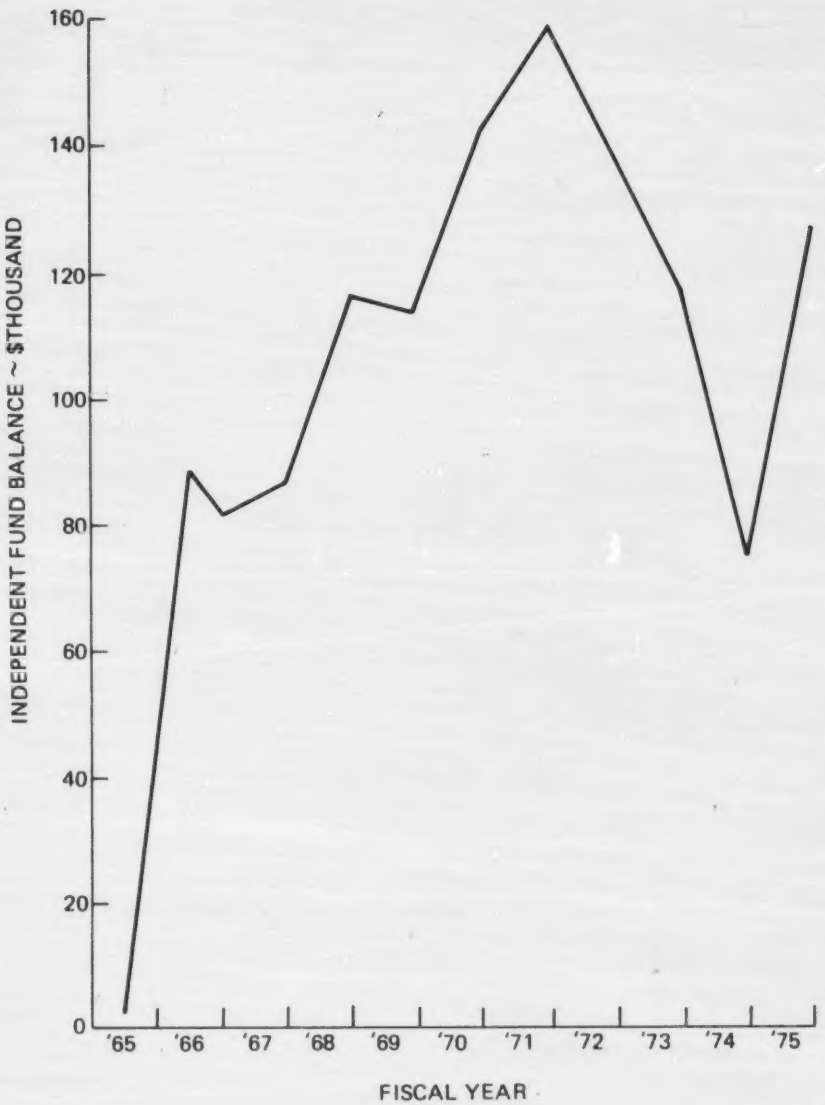


FIGURE 1 National Academy of Engineering History of Independent Fund Balance

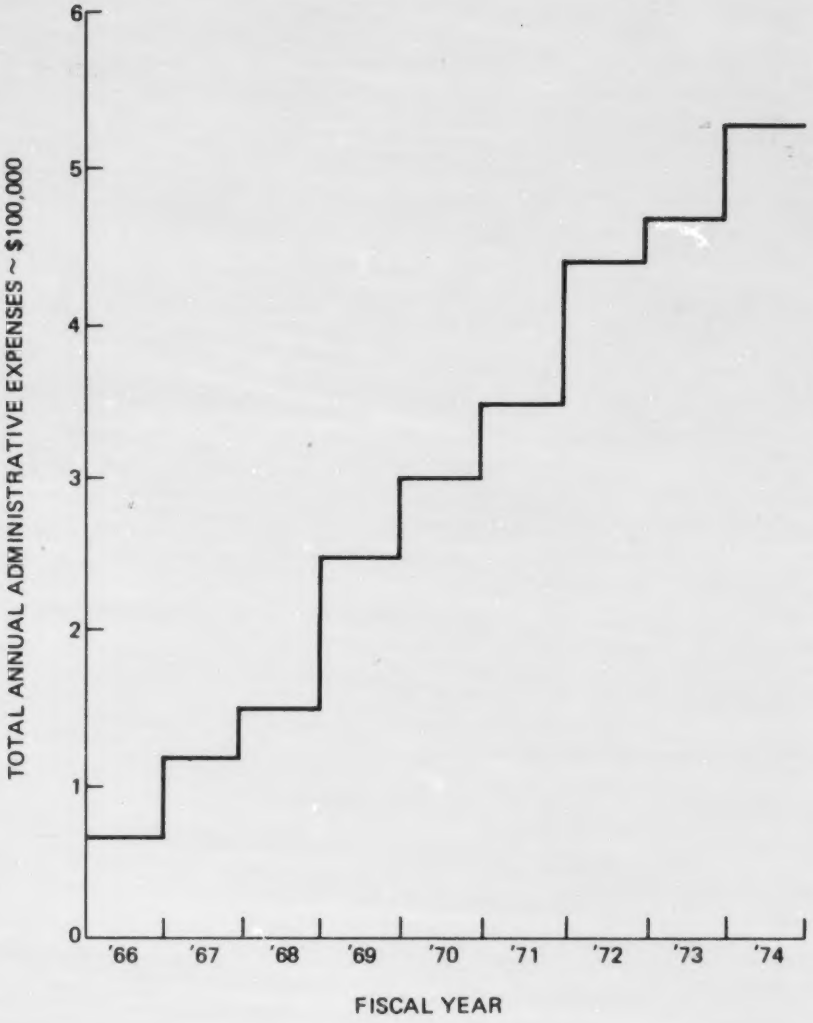


FIGURE 2 National Academy of Engineering History of Total Annual Administrative Expenses

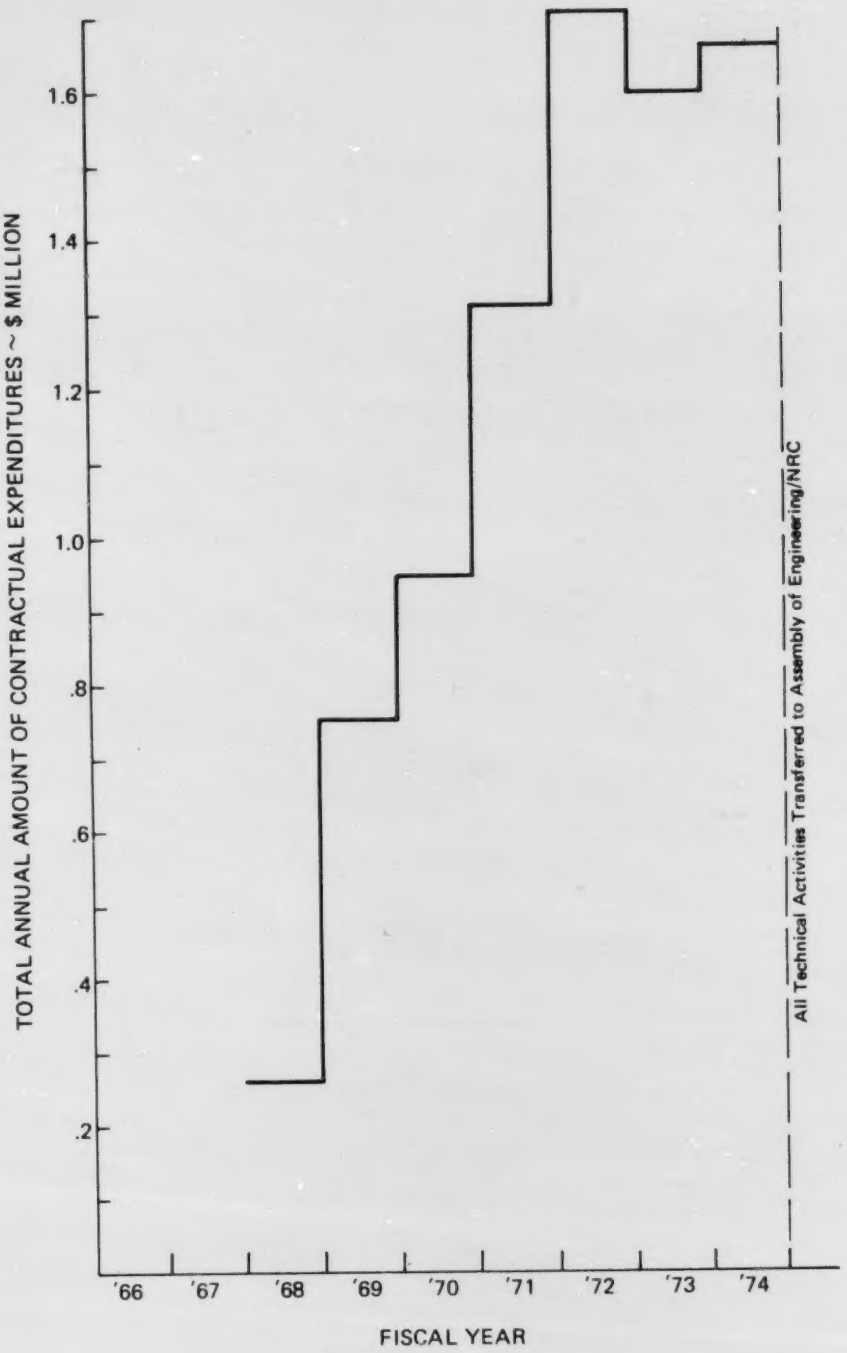


FIGURE 3 National Academy of Engineering History of Total Annual Contractual Expenditures

APPENDIX VII

PUBLICATIONS
of the
National Academy of Engineering
1964 - 1974

PUBLICATIONS OF THE

NATIONAL ACADEMY OF ENGINEERING

1964 - 1974

PROCEEDINGS OF SYMPOSIA AND CONFERENCES

Traffic Safety. 1966 Annual Meeting.

What Should the National Academy of Engineering do about Engineering Education? 1966 Autumn Meeting.

Science, Engineering, and the City. 1967 Annual Meeting.

Engineering for the Benefit of Mankind. 1967 Autumn Meeting.

Costs of Health Care Facilities. Proceedings of a conference, December, 1967.

The Process of Technological Innovation. 1968 Annual Meeting.

Helicopter and V/STOL Noise Generation and Suppression. Report by the Aeronautics and Space Engineering Board of the results of a joint U.S. Army, NAS, and NAE conference. July, 1968.

Engineering and Medicine. 1968 Autumn Meeting.

Public Safety -- A Growing Factor in Modern Design. 1969 Annual Meeting.

The Engineer and the City. 1969 Autumn Meeting.

Systems Approaches to the City -- A Challenge to the University. Summary proceedings of a workshop sponsored by NAE and NSF. October, 1969.

The Food-People Balance. 1970 Annual Meeting.

Evaluation of Mobility Aids for the Blind. Proceedings of a conference, June 22-23, 1970.

Technology and International Trade. 1970 Autumn Meeting.

Sensory Training Aids for the Hearing Impaired. Proceedings of a conference, November 15-17, 1970.

Product Quality, Performance, and Cost. Summary Report. 1971 Annual Meeting.

Product Quality, Performance, and Cost. Final Report. 1971 Annual Meeting.

Application of Technology to Improve Productivity in the Service Sector of the National Economy. Summary report and recommendations based on a symposium and workshops held during the Seventh Autumn Meeting of the NAE, November 1-2, 1971.

Summary of Forum II Proceedings. Summary proceedings of a conference on power plant siting organized by the Committee on Power Plant Siting, April, 1972.

Transportation and the Prospects for Improved Efficiency. Proceedings of a symposium held during the Eighth Autumn Meeting of the NAE, October 12-13, 1972.

Proceedings -- Symposium on Increasing Minority Participation in Engineering. Proceedings of a symposium organized by the Commission on Education, May 6-8, 1973.

Earthquake Environment Simulation. Final report and proceedings of a workshop, September 7-9, 1973.

National Materials Policy. Proceedings of a joint meeting of the NAS and NAE held in connection with the Ninth Autumn Meeting of the NAE, October 25-26, 1973.

OFFICE OF THE FOREIGN SECRETARY

Meeting the Challenge of Industrialization: A Feasibility Study for an International Industrialization Institute. Report of a special international panel of the Board on Science and Technology for International Development. Office of the NAS Foreign Secretary, with the collaboration of the National Academy of Engineering. 1973.

U. S. International Firms and R,D,&E in Developing Countries. Report of an ad hoc panel of the Board on Science and Technology for International Development. Office of the NAS Foreign Secretary with the collaboration of the National Academy of Engineering. 1973.

REPORTS OF COMMITTEES OF THE NAE

Aeronautics and Space Engineering Board

Helicopter and V/STOL Noise Generation and Suppression. Report by the Aeronautics and Space Engineering Board of the results of a joint U.S. Army, NAS, and NAE conference. July, 1968.

Civil Aviation Research and Development: An Assessment of Federal Government Involvement -- Summary Report. Report to the National Aeronautics and Space Administration. August, 1968.

Civil Aviation Research and Development: An Assessment of Federal Government Involvement -- Aircraft Noise. Ad hoc committee report. December, 1968.

Civil Aviation Research and Development: An Assessment of Federal Government Involvement -- Air Traffic Control. Ad hoc committee report. December, 1968.

Civil Aviation Research and Development: An Assessment of Federal Government Involvement -- Aircraft Operations. Ad hoc committee report. December, 1968.

Civil Aviation Research and Development: An Assessment of Federal Government Involvement -- Airport and Support Activities. Ad hoc committee report. December, 1968.

Civil Aviation Research and Development: An Assessment of Federal Government Involvement -- Economics of Civil Aviation. Ad hoc committee report. December, 1968.

Civil Aviation Research and Development: An Assessment of Federal Government Involvement -- Flight Vehicles and Airbreathing Propulsion. Ad hoc committee report. December, 1968.

Bureau of Mines, Committee Advisory to the

Study of the Need for an Advisory Committee for the Bureau of Mines. July, 1973.

Education, Commission on

A Notebook of Films for Engineering Education. 1961

Educational Technology in Higher Education -- The Promises and Limitations of ITV and CAI. 1969.

Computer-Oriented Electrical Engineering Experiments, 1969-1970. December, 1969.

Social Directions for Technology. Memorandum of a workshop. June, 1971.

CACHE Physical Properties Data Book. August, 1972.

Proceedings -- Symposium on Increasing Minority Participation in Engineering. Proceedings of a symposium held on May 6-8, 1973.

Real Time Task Force. Summary of a study by the CACHE Committee. October, 1973.

Issues and Public Policies in Educational Technology: To Realize the Promise. Advisory Committee on Issues in Education Technology. 1974.

COSINE Task Force Publications

Some Specifications for a Computer-Oriented First Course in Electrical Engineering. Task Force I. September, 1968.

An Undergraduate Electrical Engineering Course on Computer Organization. Task Force II. October, 1968.

Some Specifications for an Undergraduate Course in Digital Subsystems. Task Force III. November, 1968.

Impact of Computers on Electrical Engineering Education -- A View from Industry. Task Force V. September, 1969.

An Undergraduate Computer Engineering Option for Electrical Engineering. Task Force IV. January, 1970.

Digital Systems Laboratory Courses and Laboratory Development. Task Force VI. March, 1971.

An Undergraduate Course on Operating Systems Principles. Task Force VIII. June, 1971.

Minicomputers in the Digital Laboratory Program. Task Force VII. April, 1972.

Energy, Task Force on

U. S. Energy Prospects: An Engineering Viewpoint. May, 1974.

Engineering Manpower Policy, Committee on

Engineering and Scientific Manpower: Recommendations for the Seventies. 1973.

Environmental Engineering, Committee on
(Formerly Committee on Engineering Aspects of Environmental Quality)

Study of the Navy Environmental Protection Data Base. Report to the Naval Civil Engineering Laboratory by the Navy Environmental Protection Program Study Group. March, 1974.

Industrialized Housing, Committee on

Industrialized Housing: An Inquiry Into Factors Influencing Entry Decisions by Major Manufacturing Corporations. 1972.

Integrated Utility Systems Board

Evaluation of Integrated Utility Systems. A report to the Office of Policy and Development Research, Department of Housing and Urban Development. 1974.

Interplay of Engineering with Biology and Medicine, Committee on the

Prototype University Plans for the Development of Biomedical Engineering. Report to the National Institutes of Health. April, 1969.

Engineering and Medicine. Proceedings of a symposium held in connection with the Fourth Autumn Meeting of the NAE, October 30-31, 1968. 1970.

Government Patent Policy. Report to the National Institutes of Health. March, 1970.

Evaluation of Mobility Aids for the Blind. Proceedings of a conference, June 22-23, 1970.

Sensory Training Aids for the Hearing Impaired. Proceedings of a conference, November 15-17, 1970.

An Assessment of Industrial Activity in the Field of Biomedical Engineering. 1971.

Sensory Aids for the Handicapped: A Plan for Effective Action. December, 1971.

Federal Agency Development in Medical Engineering. Report of the Subcommittee on Interaction with Industry. 1973.

Selected Research, Development and Organizational Needs to Aid the Hearing Impaired. Report of the Subcommittee on Sensory Aids. May, 1973.

Selected Research, Development and Organizational Needs to Aid the Visually Impaired. Report of the Subcommittee on Sensory Aids. May, 1973.

Study of Engineering in Medicine and Health Care. Final report to the National Institutes of Health. June, 1973.

Study of Aerospace Technology Utilization in the Civilian Biomedical Field, and three supplements: "Report on Pulmonary Care" (1970); "Report on Cardiovascular Care" (1970); "Emergency Medical Communications" (1972). Final report to the National Aeronautics and Space Administration. November, 1973.

Marine Board
(Formerly Committee on Ocean Engineering)

An Oceanic Quest: The International Decade of Ocean Exploration. Report prepared jointly by the Committee on Oceanography (NAS/NRC) and the Committee on Ocean Engineering (NAE). April, 1969.

Background Papers for Coastal Wastes Management. 1969.

Waste Management Concepts for the Coastal Zone -- Requirements for Research and Investigation. October, 1970.

Outer Continental Shelf Resource Development Safety: A Review of Technology and Regulation for the Systematic Minimization of Environmental Intrusion from Petroleum Products. Panel on Operational Safety in Offshore Resource Development. December, 1972.

Toward Fulfillment of a National Ocean Commitment. 1972.

Civil Manned Undersea Activity: An Assessment. Report prepared jointly by the Ocean Affairs Board (NAS/NRC) and the Marine Board (NAE). 1973.

First Report of the Review Committee on Safety of Outer Continental Shelf Petroleum Operations to the United States Geological Survey. January, 1974.

Deepwater Oil Terminals -- Position Paper. January, 1974.

Second Report of the Review Committee on Safety of Outer Continental Shelf Petroleum Operations to the United States Geological Survey. June, 1974.

Directions for Data Buoy Technology 1978-1983. A report to the Department of Navy and the National Oceanic and Atmospheric Administration by a Panel on Buoy Technology Assessment. 1974.

Mine Rescue and Survival Techniques, Committee on

Mine Rescue and Survival -- Final Report. Report to the Bureau of Mines. March, 1970.

NSF Experimental R&D Incentives Program, ad hoc Study Panel of the

Experiments in Research and Development Incentives. A final report to the National Science Foundation. June, 1974.

Power Plant Siting, Committee on

Engineering for Resolution of the Energy-Environment Dilemna: A Summary. 1971.

Engineering for Resolution of the Energy-Environment Dilemna. 1972.

Summary of Forum II Proceedings. Summary proceedings of a conference on power plant siting. April, 1972.

Project Gasoline, Advisory Committee on

Final Report of the Advisory Committee on Project Gasoline. Report to the Department of Interior. October, 1970.

Public Engineering Policy, Committee on

A Study of Technology Assessment. Report to the House Committee on Science and Astronautics. July, 1969.

Federal Support of Applied Research. Report to the National Science Foundation of the Ad Hoc Task Force on Roles of the Federal Government in Applied Research. 1970.

Priorities in Applied Research: An Initial Appraisal. Report to the National Science Foundation. 1970.

Perspectives on Benefit-Risk Decision Making. Report of a colloquium. 1972.

Priorities for Research Applicable to National Needs. Report of an ad hoc steering committee for the study of research applied to national needs. October, 1973.

Technology Transfer and Utilization, Committee on

Technology Transfer and Utilization: Recommendations for Redirecting the Emphasis and Correcting the Imbalance. Report to the National Science Foundation. February, 1974.

Telecommunications, Committee on

Reports on Selected Topics in Telecommunications. Report to the Department of Housing and Urban Development. December, 1968.

Telecommunications for Enhanced Metropolitan Function and Form. August, 1969.

The Application of Social and Economic Values to Spectrum Management. Interim Report. August, 1969.

The Application of Social and Economic Values to Spectrum Management. Final Report. June, 1970.

Communications Technology for Urban Improvement. Final Report. June, 1971.

Telecommunications Research in the United States and Selected Foreign Countries: A Preliminary Survey. Vol. I: Summary; Vol. II: Individual Contributions. Report of the committee's Panel on Telecommunications Research to the National Science Foundation. June, 1973.

Transportation, Committee on

Urban Transportation Research and Development. Report to the U.S. Department of Transportation. May, 1972.

Transportation and the Prospects for Improved Efficiency. Proceedings of a symposium held during the Eighth Autumn Meeting of the NAE, October 12-13, 1972.

REPORTS OF JOINT COMMITTEES OF THE NAS/NAE/NRC

Ambulance Design Criteria, Committee on (NAS/NAE/NRC)

Ambulance Design Criteria. Report to the Department of Transportation. June, 1970.

Development Criteria for Nonrail Transit Vehicles, Advisory Committee on (NAE/NRC)

Design and Performance Criteria for Improved Nonrail Urban Mass Transit Vehicles and Related Urban Transportation Systems. Report to the U. S. Department of Housing and Urban Development. June, 1968.

Environmental Studies Board (NAS/NAE)

Institutions for Effective Management of the Environment, Part I. Study Group Report. January, 1970.

Environmental Problems in South Florida, Part II. Study Group Report. March, 1970.

Jamaica Bay and Kennedy Airport: A Multidisciplinary Environmental Study, Vol. I: Conclusions, Recommendations, Summary; Vol. II: A Report of the Jamaica Bay Environmental Study Group. Report to the Port of New York Authority. 1971.

Institutional Arrangements for International Environmental Cooperation. A report to the Department of State by the Committee for International Environmental Programs. 1972.

Biological Impacts of Increased Intensities of Solar Ultraviolet Radiation. Ad Hoc Panel on the Biological Impacts of Increased Intensities of Solar Ultraviolet Radiation. 1973.

Man, Materials and Environment. A report to the National Commission on Materials Policy. 1973.

Research Needs in Water Quality Criteria: 1972. A report to the Environmental Protection Agency by the Committee on Water Quality Criteria. 1973.

Principles for Evaluating Chemicals in the Environment. A report to the Environmental Protection Agency by the Committee for the Working Conference on Principles of Protocols for Evaluating Chemicals in the Environment (NAS/NAE), and Committee on Toxicology (NRC). February, 1973.

Air Quality and Automobile Emission Control, Vol. I: Summary Report; Vol. II: Health Effects of Air Pollutants; Vol. III: The Relationship of Emissions to Ambient Air Quality; Vol. IV: The Costs and Benefits of Automobile Emission Control. Reports to the Committee on Public Works of the United States Senate by the Coordinating Committee on Air Quality Studies. September, 1974.

Rehabilitation Potential of Western Coal Lands. A report to the Energy Policy Project of the Ford Foundation by the Study Committee on the Potential for Rehabilitating Lands Surface Mined for Coal in the Western United States. 1974.

Water Quality Criteria: 1972. A report to the Environmental Protection Agency by the Committee on Water Quality Criteria. 1974.

Underground Disposal of Coal Mine Wastes. A report to the National Science Foundation by the Study Committee to Assess the Feasibility of Returning Underground Coal Mine Wastes to the Mined-Out Areas, Environmental Studies Board/Board on Energy Studies (NAS/NAE). 1975.

Housing and Urban Development, Advisory Committee to the Department of (NAS/NAE)

Freedom of Choice in Housing: Opportunities and Constraints. A report of the Social Science Panel, Division of Behavioral Sciences, NRC; and recommendations of the Advisory Committee to HUD. 1972.

Urban Growth and Land Development: The Land Conversion Process. Ad hoc committee report. 1972.

A Report on Operation BREAKTHROUGH. A report of the Technical Panel of the committee. 1974.

Revenue Sharing and the Planning Process: Shifting the Locus of Responsibility for Domestic Problem Solving. A report of the Subcommittee on the Planning Process and Urban Development. 1974.

Toward an Understanding of Metropolitan America. A report of the committee's Social Science Panel on the Significance of Community in the Metropolitan Environment, Assembly of Behavioral and Social Sciences, NRC. 1974.

Mineral Science and Technology, Committee on (NAS/NAE/NRC)

Mineral Science and Technology -- Needs, Challenges, and Opportunities. Report to the Bureau of Mines. October, 1969.

Extractive Metallurgy. Panel report. December, 1969.

Fuel Science and Technology. Panel report. December, 1969.

Mineral Economics. Panel report. December, 1969.

Mining. Panel report. December, 1969.

Nonmetallic Materials. Panel report. December, 1969.

Natural Disasters, Committee on (NAS/NAE/NRC)
(Formerly the Committee on Earthquake Engineering Research; Committee on Earthquake Engineering Inspection; and Committee on Inspection of Structural Damage Due to Earthquakes, Winds, and Other Natural Disasters)

Engineering Report on the Caracas Earthquake of 29 July 1967. November, 1968.

Earthquake Engineering Research. Report to the National Science Foundation. January, 1970.

The Gediz, Turkey Earthquake of 1970. Report to the National Science Foundation. September, 1970.

The Western Sicily Earthquake of 1968. Ad hoc committee report. January, 1970.

The Lubbock Storm of May 11, 1970. Report to the National Science Foundation. October, 1970.

The Engineering Aspects of the Qīr Earthquake of April 10, 1972 in Southern Iran. A report to the National Science Foundation prepared by Reza Razani, Pahlavi University, Iran, and Kenneth L. Lee, University of California at Los Angeles, submitted to the committee. 1973.

Destructive Earthquake in Burdur and Bingöl, Turkey -- May 1971. Report and recommendations by W. O. Keightley, Montana State University, submitted to the committee. 1973.

Pollution Abatement and Control, Committees on (NAS/NAE/NRC)

Committee on Air Quality Management

Abatement of Sulfur Oxide Emissions from Stationary Combustion Sources. COPAC-2. Ad hoc panel report to the National Air Pollution Control Administration, Public Health Service, Department of Health, Education and Welfare. 1970.

Abatement of Nitrogen Oxide Emissions from Stationary Sources. COPAC-4. Ad hoc panel report to the Environmental Protection Agency. 1972.

Abatement of Particulate Emissions from Stationary Sources. COPAC-5. Ad hoc panel report to the Environmental Protection Agency. 1972.

Evaluation of Coal-Gasification Technology: Part I -- Pipeline-Quality Gas. COPAC-6. Ad hoc panel report to the Office of Coal Research, Department of the Interior. 1972.

Evaluation of Coal-Gasification Technology: Part II -- Low- and Intermediate-BTU Fuel Gases. COPAC-7. Ad hoc panel report to the Office of Coal Research, Department of the Interior. 1973.

Committee on Solid Waste Management

Policies for Solid Waste Management. Report to the Bureau of Solid Waste Management, Public Health Service, Department of Health, Education and Welfare. September, 1969.

Committee on Water Quality Management

Acid Mine Drainage in Appalachia. Report to the Appalachian Regional Commission. June, 1969.

Rapid Excavation, Committee on (NAS/NAE/NRC)

Rapid Excavation: Significance, Needs, Opportunities. Report to the Bureau of Mines. August, 1968.

Science, Technology and Regional Economic Development, Committee on (NAS/NAE)

The Impact of Science and Technology on Regional Economic Development. Report to the Department of Commerce. August, 1969.

Scientific and Technical Communication, Committee on (NAS/NAE)

Scientific and Technical Communication: A Pressing National Problem and Recommendations for its Solution. Report to the National Science Foundation. June, 1969.

Urban Technology, Committee on (NAS/NAE)

Long-Range Planning for Urban Research and Development: Technological Considerations. Report to the Department of Housing and Urban Development. August, 1969.

APPENDIX VIII

SYMPOSIA
Held in Connection With
Annual and Autumn Meetings
of the
National Academy of Engineering
1964-1974

SYMPOSIA HELD IN CONNECTION WITH
ANNUAL AND AUTUMN MEETINGS
OF THE
NATIONAL ACADEMY OF ENGINEERING

First Annual Meeting

Symposium on the

"DYNAMICS OF STRUCTURES WITH APPLICATION TO EARTHQUAKE RESISTANCE OF TALL BUILDINGS"

April 29, 1965
Washington, D. C.

Chairman: Augustus B. Kinzel
Vice Chairman: Thomas C. Kavanagh

First Autumn Meeting

Symposium on

"SOME ASPECTS OF OCEAN ENGINEERING"

October 21, 1965
New York, New York

Chairman: Thomas C. Kavanagh

Second Annual Meeting

Symposium on

"TRAFFIC SAFETY - A NATIONAL PROBLEM"

April 28, 1966
Washington, D. C.

Chairman: J. Herbert Hollomon

Second Autumn Meeting

Symposium on

"WHAT SHOULD THE NATIONAL ACADEMY OF ENGINEERING DO ABOUT ENGINEERING EDUCATION?"

October 13, 1966
New York, New York

Chairman: Eric A. Walker

Third Annual Meeting

Symposium on

"SCIENCE, ENGINEERING, AND THE CITY"
(Held jointly with National Academy of Sciences)

April 26-27, 1967
Washington, D. C.

Chairman: John G. Truxal

Third Autumn Meeting

Symposium on

"ENGINEERING FOR THE BENEFIT OF MANKIND"

September 20-21, 1967
Ann Arbor, Michigan

Chairman: Harry F. Barr

Fourth Annual Meeting

Symposium on

"THE PROCESS OF TECHNOLOGICAL INNOVATION"

April 24, 1968
Washington, D. C.

Chairman: Francis K. McCune

Fourth Autumn Meeting

Symposium on

"ENGINEERING AND MEDICINE"

October 30-31, 1968
Washington, D. C.

Chairman: Edward E. David, Jr.

Fifth Annual Meeting

Symposia on

"THE URBAN PROBLEM"
(Held jointly with National Academy of Sciences)

and

"PUBLIC SAFETY -
A GROWING FACTOR IN MODERN DESIGN"

April 30-May 1, 1969
Washington, D. C.

Chairman: Nunzio J. Palladino

Fifth Autumn Meeting

Symposium on

"THE ENGINEER AND THE CITY"

October 22-23, 1969
Washington, D. C.

Chairman: Martin Goland

Sixth Annual Meeting

Symposium on

"THE FOOD-PEOPLE BALANCE"

April 29-30, 1970
Washington, D. C.

Chairman: Richard D. DeLauer

Sixth Autumn Meeting

Symposium on

"TECHNOLOGY AND INTERNATIONAL TRADE"

October 14-15, 1970
Washington, D. C.

Chairman: John R. Pierce

Seventh Annual Meeting

Symposium on

"PRODUCT QUALITY, PERFORMANCE, AND COST"

April 28-30, 1971
Washington, D. C.

Chairman: H. Guyford Stever

Seventh Autumn Meeting

Symposium on

"APPLICATION OF TECHNOLOGY TO IMPROVE PRODUCTIVITY IN THE SERVICE SECTOR OF THE NATIONAL ECONOMY"

November 1-2, 1971
Washington, D. C.

Chairman: George M. Low

Eighth Annual Meeting

Symposium on

"INDUSTRIALIZED HOUSING"

April 27, 1972
Washington, D. C.

Chairman: Eric A. Walker

Eighth Autumn Meeting

Symposium on

"TRANSPORTATION AND THE PROSPECTS FOR IMPROVED EFFICIENCY"

October 12-13, 1972
Washington, D. C.

Chairman: Seymour W. Herwald

Ninth Annual Meeting

REPORTS FROM THE NAE COMMITTEES

May 3-4, 1973
Washington, D. C.

Ninth Autumn Meeting

Joint NAS-NAE Meeting on

"NATIONAL MATERIALS POLICY"

October 25-26, 1973
Washington, D.C.

Chairman: Robert I. Jaffee

Tenth Annual Meeting

REPORTS FROM THE NAE COMMITTEES

May 2-3, 1974
Washington, D. C.

Tenth Autumn Meeting

Presentations on

"SURVIVAL - A NATIONAL GOAL
FOR LIVING WITHIN OUR RESOURCES"

October 10, 1974
Washington, D. C.

Chairman: John G. Linvill

APPENDIX IX

ARTICLES OF ORGANIZATION AND BYLAWS

The Articles of Organization were approved by the Council of the National Academy of Sciences on December 5, 1964.

The Bylaws were adopted by the Founding Members at the Organizing Meeting of the National Academy of Engineering held on December 10, 1964.

The text reproduced herein is that of the seventh edition, revised, and includes amendments to the Bylaws made on March 17, 1965, March 24, 1966, February 20, 1967, April 25, 1968, October 31, 1968, May 2, 1969, April 30, 1970, and May 2, 1974.

ARTICLES OF ORGANIZATION

ARTICLE I CREATION AND COMPLETION OF ORGANIZATION

The National Academy of Sciences, under the authority conferred upon it by its Charter enacted by the Congress, adopts the following Articles of Organization for the National Academy of Engineering.

SECTION 1. The National Academy of Engineering (hereinafter called the "Academy") shall be an institution with the powers, limitations, and restrictions contained in these articles of organization.

SECTION 2. The following persons are named as the Founding Members of the Academy: Hendrik Wade Bode, Walker Lee Cisler, Hugh Latimer Dryden, Elmer William Engstrom, William Littell Everitt, Antoine Marc Gaudin, Michael Lawrence Haider, George Edward Holbrook, John Herbert Hollomon, Jr., Thomas Christian Kavanagh, Augustus Braun Kinzel, James Nobel Landis, Clarence Hugo Linder, Clark Blanchard Millikan, Nathan Mortimore Newmark, William Hayward Pickering, Simon Ramo, Arthur Emmons Raymond, Thomas Kilgore Sherwood, Julius Adams Stratton, Chauncey Guy Suits, Frederick Emmons Terman, Charles Allen Thomas, Eric Arthur Walker, Ernst Weber.

SECTION 3. The Founding Members are authorized to complete the organization of the Academy by the selection of officers and employees, the adoption of bylaws not inconsistent with these articles of organization, the election of such additional members as they may deem appropriate prior to the first annual meeting of the Academy, and the doing of such further acts as may be necessary for such purpose.

ARTICLE II OBJECTS AND PURPOSES

The objects and purposes of the Academy shall be:

1. To provide means of assessing the constantly changing needs of the nation and the technical resources that can and should be applied to them; to sponsor programs aimed at meeting these needs; and to encourage such engineering research as may be advisable in the national interest.

2. To explore means for promoting cooperation in engineering in the United States and abroad, with a view to securing concentration on problems significant to society and

encouraging research and development aimed at meeting them.

3. To advise the Congress and the executive branch of the government, whenever called upon by any department or agency thereof, on matters of national import pertinent to engineering.

4. To cooperate with the National Academy of Sciences on matters involving both science and engineering.

5. To serve the nation in other respects in connection with significant problems in engineering and technology.

6. To recognize in an appropriate manner outstanding contributions to the nation by leading engineers.

ARTICLE III POWERS

The Academy shall have power:

1. To adopt, alter, and use an official seal.

2. To adopt, amend, and alter bylaws, not inconsistent with these articles of organization, for the regulation of its affairs.

3. To elect additional members.

4. To choose such officers, members of its Council, managers, agents, and employees as the business of the Academy may require.

5. To control and administer any property, real or personal, necessary or proper for attaining the objects and carrying into effect the purposes of the Academy.

6. To make contracts for the performance of services and for the disposition of funds or property that are under its control, in accordance with procedures to be established jointly by the Councils of the National Academy of Engineering and the National Academy of Sciences.

7. To do any other acts and things, not inconsistent with these articles of organization, as may be necessary and proper to carry out the purposes of the Academy. -

provided, however, that the foregoing powers shall not be construed to authorize any act that is inconsistent with Section 501(c) (3) of the Internal Revenue Code or comparable statutory tax-exemption provisions, or with the provisions of the Act of Incorporation of the National Academy of Sciences, as amended.

ARTICLE IV PRINCIPAL OFFICE; SCOPE OF ACTIVITIES

The principal office of the Academy shall be located in the District of Columbia. The activities of the Academy may be conducted there or elsewhere.

ARTICLE V MEMBERSHIP

A person shall be qualified as a candidate for membership in the Academy if he personally has made identifiable contributions or accomplishments in one or both of the following categories:

1. Important contributions to engineering theory and practice, including significant contributions to the literature of engineering.

2. Demonstration of unusual accomplishments in the pioneering of new and developing fields of technology.

A candidate for membership shall be recognized by his associates and others for his professional integrity, as well as for his engineering accomplishments. Effectiveness and efficiency in leadership of organizations that have conducted pioneering or complex programs or that have made noteworthy contributions to the field of engineering education should be weighed as supplementing the primary qualifications outlined above.

ARTICLE VI COUNCIL; COMPOSITION; RESPONSIBILITIES

SECTION 1. The composition, terms of office, and manner of election of the Council of the Academy shall be established by its bylaws, except that the President of the National Academy of Sciences, by virtue of his office, shall be a member of the Council of the National Academy of Engineering and of its Executive Committee.

SECTION 2. The Council shall be the governing board of the Academy and shall, during intervals between meetings of the members, be responsible for the general policies and programs of the Academy. The Council shall be responsible for the control of all funds administered by the Academy.

SECTION 3. The Council may authorize the payment of compensation to the officers and staff of the Academy for their services as may from time to time be appropriate. In addition, the Council may authorize reimbursement of the officers and and members of the Council and of all committees for traveling

and other incidental expenses incurred in carrying on the work of the Academy.

ARTICLE VII OFFICERS

The officers of the Academy shall be a president, one or more vice presidents, a secretary, a treasurer, and such other officers as may be prescribed in its bylaws.

ARTICLE VIII COOPERATION BETWEEN THE ACADEMIES

SECTION 1. The Council of the National Academy of Engineering and the Council of the National Academy of Sciences shall each select an equal number of persons to serve as a Joint Board to recommend policies and modes of operation for accomplishing the most effective cooperation between the two Academies and to perform such other functions as may be assigned to it by joint action of the Councils of the two Academies.

SECTION 2. The National Academy of Engineering shall be solely responsible for the content of reports on projects that it undertakes, and such reports may be issued in its own name.

SECTION 3. Prior to the expiration of each term of office of the chairman of the division of Engineering and Industrial Research* of the National Research Council, the Council of the National Academy of Engineering shall present to the Council of the National Academy of Sciences the name or names of persons whom the Council of the National Academy of Engineering recommends for appointment to the position.

SECTION 4. In dealing with the Congress and in matters involving other countries, the National Academy of Engineering shall work jointly with the National Academy of Sciences.

ARTICLE IX MINUTES; FINANCIAL RECORDS

SECTION 1. The Academy shall keep minutes of the proceedings of its members, Council, and committees having authority under the Council. It shall also keep books and records of its financial transactions.

---

*now Division of Engineering.

SECTION 2. After the close of each fiscal year, the accounts of the Academy shall be audited by independent certified public accountants. A report of such audit shall be made to the Councils of the National Academy of Engineering and the National Academy of Sciences.

ARTICLE X RESTRICTIONS ON ACTIVITIES

SECTION 1. No part of the income or assets administered by the Academy shall inure to any member or official of the Academy or member of the Council, or be distributable to any such person during the life of the Academy or upon its dissolution or final liquidation. Nothing in this section, however, shall be construed to prevent the payment of reasonable compensation to any such person as authorized in Section 3 of Article VI hereof.

SECTION 2. No substantial part of the activities of the Academy shall consist of carrying on propaganda or otherwise attempting to influence legislation.

ARTICLE XI USE OF ASSETS ON DISSOLUTION OR LIQUIDATION

Upon final dissolution or liquidation of the Academy, and after discharge or satisfaction of all the outstanding obligations and liabilities for which it is responsible, the remaining assets in the hands of the Academy shall be distributed in a manner that is consistent with the purposes of the National Academy of Engineering and in accordance with all applicable restrictions and obligations of the National Academy or Sciences. Except as provided in Article XII hereof, such distribution shall be determined by the Council of the National Academy of Sciences.

ARTICLE XII DISPOSITION OF ASSETS UPON INCORPORATION

Should the Academy be incorporated independently at a later date, all permanent assets under its control (whether by way of endowment or otherwise) shall be transferred to such new corporation, provided that such transfer is not inconsistent with Section 501(c) (3) of the Internal Revenue Code and comparable statutory tax-exemption provisions. The disposition of any funds or property that the Academy is then administering under grants, contracts, and the like shall be determined by agreement between the presidents of the National Academy of Engineering and the National Academy of Sciences.

ARTICLE XIII AMENDMENTS

Any proposed amendment to these articles of organization shall be considered by the Council of the Academy and, if two-thirds of the Council approve the same, it shall be submitted to the Council of the National Academy of Sciences. If the latter approves the proposed amendment, the Council of the National Academy of Engineering shall report thereon to the members of that Academy at their next stated meeting. If the proposition is considered favorably by a majority of the members present, it shall be submitted, by notice given to all members of the Academy not less than thirty days in advance, for final action at their next stated meeting. Members who are unable to attend that meeting may send their votes on the proposed amendment to the secretary, and such votes shall be counted as if the members were present. If the proposed amendment is approved by a majority of the votes cast, it shall be declared adopted.

BYLAWS

ARTICLE I SEAL

The seal of the National Academy of Engineering (hereinafter called the "Academy") shall be in the form of a circle and shall have inscribed thereon:

National Academy of Engineering, 1964, Official Seal

ARTICLE II MEMBERS, MEMBERS EMERITI, AND FOREIGN ASSOCIATES

SECTION 1. *Composition.* The Academy shall consist of members, members emeriti, and foreign associates. There shall be no age limit on any of these categories.

SECTION 2. *Members.* The qualifications of candidates for membership in the Academy are stated in Article V of the Articles of Organization. Members must be citizens of the United States.

SECTION 3. *Members Emeriti.* Members having reached the age of seventy who have been on the rolls of the Academy for five years and who wish to be relieved of the status of active membership may, at their own request, be transferred to the roll of members emeriti. A member emeritus shall not be subject to dues or assessments and shall not be eligible to serve as an officer, a member of the Council, or a chairman of a standing committee. A member emeritus shall have all other privileges of a member, including the right to vote on Academy matters and to serve as a member of committees.

SECTION 4. *Foreign Associates.* Candidates for election as foreign associates shall meet the requirements for qualification for membership, but shall be nationals of other countries. Foreign associates shall have the privilege of attending meetings and of reading and communicating papers to the Academy, but shall take no part in its business and shall not be subject to its dues or assessments. A foreign associate of the Academy who becomes a citizen of the United States shall have all the privileges and duties of a member of the Academy, including listing in the roster of members, unless he shall request otherwise.

SECTION 5. *Dues.* The amount of the annual membership dues shall be recommended by the Council and fixed by the members and shall be payable by the members within thirty days after commencement of the fiscal year for which they are assessed. In the case of newly elected members, dues shall commence with the fiscal year next following the date of election and shall be payable within thirty days of acceptance of election.

SECTION 6. *Nomination and Election.* Nomination and election of members and foreign associates of the Academy shall be in accordance with procedures developed by the Committee on Membership and approved by the Council. The procedures shall provide for the Council to fix annually the maximum number of new members and new foreign associates to be elected, for nominations to be submitted by members of the Academy to the Committee on Membership, for evaluation of these nominations and subsequent recommendations to the Council by the Committee on Membership, and for presentation of nominees by the Council to the members of the Academy for election.

SECTION 7. *Notification and Acceptance.* Each member-elect or foreign associate-elect shall, immediately following his election, be notified thereof in writing by the secretary. Each person elected to membership must accept the invitation, in writing, before the close of the next stated meeting of the Academy. Otherwise, on proof that the secretary has formally notified him of his election, his name shall not be entered on the roll of members.

A diploma, with the official seal of the Academy and the signatures of the officers, shall be supplied by the secretary to each member on his acceptance of membership and to foreign associates on their election.

SECTION 8. *Termination.* Resignation from membership shall be addressed to the president and acted on by the Council.

ARTICLE III MEETINGS OF THE ACADEMY

SECTION 1. *Stated Meetings.* The Academy shall hold one stated meeting, called the annual meeting, in the second quarter of each year in the City of Washington, District of Columbia, and another stated meeting, called the autumn meeting, at a place to be determined by the Council. The Council shall also have the power to fix the date of each meeting. Written notice of the time and place of each meeting shall be given to each member of the Academy not less than thirty days prior thereto.

SECTION 2. *Annual Meeting.* The annual meeting shall consist of business sessions and technical sessions. At the business

sessions, the meeting shall receive any reports deemed appropriate by the officers and the Council; shall consider matters referred to it by the Council, and shall transact such other business as may properly come before it. At the technical sessions, the meeting shall receive and discuss communications on engineering subjects.

SECTION 3. *Autumn Meeting.* If matters of business are included by the Council in the call of the autumn meeting, one part of the meeting shall consist of a business session. Otherwise, the autumn meeting shall consist solely of technical sessions.

SECTION 4. *Special Meetings.* The Council may call special meetings of the Academy at such times and places and for such purposes as it may designate in the notice of call. The Council shall give not less than thirty days' written notice of the time, place, and purpose of all special meetings.

SECTION 5. *Voting.* Each member and member emeritus of the Academy shall be entitled to one vote on each matter submitted to a vote at any meeting, but no member whose dues have been in arrears for a period of six months prior to the meeting shall be entitled to vote.

SECTION 6. *Quorum.* Forty members, present in person, shall constitute a quorum at any business session of a stated or special meeting.

ARTICLE IV FISCAL YEAR

The fiscal year of the Academy shall be from July 1 of each year to June 30 of the year following.

ARTICLE V COUNCIL

SECTION 1. *Membership; Term.* The Council of the Academy shall consist of the president, vice president, and treasurer of the Academy; the president of the National Academy of Sciences; the vice chairman of the National Research Council; and twelve members of the Academy to be elected by the membership. In addition, the immediate past president of the Academy shall be a member of the Council for a period of one year immediately following the conclusion of his term of office.

The terms of the twelve members of the Council who are elected by the membership shall be arranged on a staggered basis. Thereafter, at each annual meeting, four members of the Academy shall be elected to serve on the Council for a term of three years. The

term of each member of the Council shall expire at the close of the annual meeting at which his successor is elected, except that the term of a retiring president of the Academy shall expire one year after his retirement.

SECTION 2. *Vacancies.* Any vacancy on the Council between annual meetings may be filled by the majority of the remaining members of the Council. The person so elected shall serve until the next annual meeting of the Academy, at which time a successor shall be elected, as nearly as possible in accordance with Section 4 of Article VII of these bylaws, to fill the unexpired term.

SECTION 3. *Functions.* Subject to the provisions of the Articles of Organization of the Academy and these bylaws, the Council shall have paramount authority with respect to the funds, activities, policies, and purposes of the Academy. The Council shall have power to adopt the annual general budget of the Academy and to appoint and fix the salaries of the personnel who may be deemed necessary for the conduct of its affairs.

SECTION 4. *Meetings.* The Council shall meet immediately following the annual meeting of the Academy, and notice of such meeting shall not be required. The Council shall also meet at least three other times per year with the time and place of each meeting set forth in a written notice to all members of the Council at least ten days prior to the date of each meeting.

In addition, the Council shall hold such special meetings as the president or three members of the Council, by written request to the president, may call, at such time and place and for such purpose as is designated by the president or by those members who have called the meeting. The president shall give to all members of the Council not less than five days' written or three days' telegraphic notice of the time, place, and purpose of each special meeting.

Eight members of the Council shall constitute a quorum at all meetings thereof.

SECTION 5. *Executive Committee.* There shall be an Executive Committee of the Council, consisting of the president, vice president, and treasurer of the Academy; the president of the National Academy of Sciences; and four members appointed annually by, and from, the Council of the Academy. The president of the Academy shall be the chairman of the Executive Committee and the secretary of the Academy shall act as secretary of the Committee. Four members of the Committee shall constitute a quorum at all meetings thereof.

During intervals between meetings of the Council, the Executive Committee may exercise all the powers of the Council except that the Committee may not fill vacancies on the Council or among

the officers of the Academy, exercise the powers of the Council with respect to nominations to membership in the Academy, or do any other acts that are expressly prohibited to the Committee by the Council.

The Executive Committee may, in the discretion of the president of the Academy, conduct any of its affairs by mail, telephonic, or telegraphic vote of all the members of such Committee, provided that any question so decided shall have been transmitted to every member of the Committee in the same wording. An affirmative vote of a majority of the Councillors shall be necessary for action, and all members of the Committee shall be appraised of the vote before the result of the poll on questions so submitted is recorded by the chairman.

The Executive Committee shall hold such meetings as the chairman or any three members of the Committee may by written request call, at such time and place and for such purposes as are designated by the chairman or by the three members who have called the meeting. The chairman shall give to every member of the Committee not less than five days' written or three days' telegraphic notice of the time, place, and purpose of each meeting of the Committee.

The Executive Committee shall keep regular minutes and shall report on its proceedings to the Council.

ARTICLE VI OFFICERS

SECTION 1. *General.* The officers of the Academy shall be a president and a vice president, who shall be members of the Council, and such other officers, including a secretary and a treasurer (who need not be Academy members), as the Council from time to time may determine.

SECTION 2. *Election; Term.* The president, vice president, secretary, and treasurer shall be elected for a term of four years commencing with the close of the annual meeting at which their election is announced and ending with the close of the annual meeting at which the election of their successors is announced. The aforesaid officers shall be elected as specified in Section 4 of Article VII of these bylaws. In case of a vacancy the election shall be held as nearly as possible in the same manner prior to the next business meeting of the Academy and shall be for the unexpired term, except that a vacancy in the office of the treasurer or secretary may be filled by appointment of the president until the next business session of the Academy.

The president, vice president, secretary, and treasurer shall be elected for a term of four years commencing with the close of the annual meeting at which their election is announced and ending with the close of the annual meeting at which the election of their successors is announced. Any other offices created by

the Council shall be filled by appointment of the Council, for such terms as the Council may determine.

SECTION 3. *Duties of Officers.*

a. *President.* The president shall be the chief executive officer of the Academy and, with the Council, shall direct the general business of the Academy. He shall preside at all meetings of the Academy and the Council. He shall submit a report each year of the activities of the Academy to the Council at its regular meeting next preceding the annual meeting and to the Academy at its annual meeting. He shall be ex officio a member of all standing committees, in addition to those committee members specified in Article VII of these bylaws. In general, he shall have all the powers and duties of supervision and management usually vested in the office of the president of any institution of this character.

b. *Vice President.* The vice president shall be vested with all the powers and required to perform all the duties of the president in his absence or during his disability and shall perform such other duties as may be prescribed by the Council. He shall be ex officio a member of all standing committees in addition to those committee members specified in Article VII of these bylaws.

c. *Secretary.* The secretary shall attend all meetings of the Academy and all meetings of the Council and the standing committees. He shall record all the proceedings of such sessions and meetings in a book or books kept for that purpose and, after approval by the Council, shall enter the minutes of business and technical meetings of the Academy in its permanent records.

He shall conduct and be responsible for the correspondence of the Academy, as directed by the Council and the president.

He shall acknowledge receipt of all contributions made to the Academy, shall keep records thereof, and shall report them promptly to the Council for its consideration. He shall keep a record of all grants of money and awards of prizes made by the Academy, in the form prescribed by the president and Council.

He shall give proper notice of all meetings of the Academy and the Council and of all nominations for officers, membership in the Council, and membership in the Academy.

He shall have custody of the seal of the Academy and shall affix it to all documents as authorized by the Council or the president.

d. *Treasurer.* The treasurer shall be responsible for all receipts and disbursements of the Academy; shall ensure that full and accurate accounts thereof are kept; and shall be responsible

for the deposit, in such institutions as may be designated by the Council, of all monies, securities, and other valuable effects that are under the administration or control of the Academy. In fulfilling the foregoing responsibilities, he may use the services of the staff of the Academy or he may arrange for use of the services of the National Academy of Sciences. He shall give such bond as the Council may require.

He shall ensure that dues, assessments, and subscriptions are collected from the members and that appropriate records thereof are kept. He shall disburse the funds of the Academy as may be ordered by the Council or the president and shall render to the Council or the president, whenever it may be required, an account of all his transactions as treasurer.

Not later than the first day of December of each year, the treasurer shall prepare and submit to the Council a full report of the financial affairs of the Academy for the preceding fiscal year, including all receipts and disbursements. He shall also prepare and present to the Council at least sixty days prior to the annual meeting and to the Academy at its annual meeting a financial statement for that part of the current fiscal year ending on December 31.

SECTION 4. *Delegation of Duties of Officers.* In case of the absence or disability of any officer of the Academy or for any reason deemed sufficient by the Council, the powers or duties, or both, of such officer may be delegated by the Council to any other officer or member of the Council.

ARTICLE VII COMMITTEES

SECTION 1. *Finance Committee.* There shall be a Finance Committee, consisting of the treasurer, the president of the National Academy of Sciences, and not more than six members of the Academy appointed annually by the president. The treasurer of the Academy shall be chairman of the Finance Committee. The Committee shall prepare and present to the Council the annual general budget of the Academy and shall determine matters relating to the purchase and sale of securities or other investments that are under the administration or control of the Academy. The Committee shall have the power, subject to the approval of the Council, to employ competent investment counsel to advise the Committee.

SECTION 2. *Auditing Committee.* At each annual meeting of the Academy the president shall appoint an Auditing Committee consisting of three members, one of whom shall be named by the president as chairman of the Committee. The Committee shall arrange for an audit, by independent certified public accountants,

of the accounts of the Academy for the current fiscal year and shall present the report of audit to the Academy at the next annual meeting, together with such comments and recommendations as the Committee may deem appropriate. The Committee may cause to be made any other examinations of the financial records, the accounting records, and the system of internal control of the Academy that, in its judgment, are necessary for the determination of the adequacy and accuracy of the accounts of the Academy.

SECTION 3. *Committee on Membership.* There shall be a Committee on Membership, composed of not less than sixteen nor more than thirty members appointed by the Council, after taking into account the various branches of engineering represented in the Academy. The Council shall annually name the chairman and vice chairman of the Committee. The vice chairman shall, under normal circumstances, succeed to a one-year term as chairman.

The members of the Committee shall be appointed for terms of three years, each of which, as nearly as possible, shall be on a staggered basis. The functions of the Committee shall be to analyze the membership structures of the Academy, to originate nominations, and to appraise nominations received from the members.

SECTION 4. *Nominating Committee.* The president, with the approval of the Council, shall annually appoint a Nominating Committee composed of five members, one of whom shall be a member of the Council and one of whom shall be named as chairman, to prepare nominations to fill any vacancies that will occur in that year in the Council or among the officers of the Academy. There shall be a complete rotation of the members of the Committee each year, except that the chairman of the Committee in any given year shall automatically become a member (but not the chairman) of the Committee for the following year; and no member of the Committee may serve again until three years after his term has expired.

Not less than ninety days prior to the opening of the annual meeting in each year, any group of not less than forty members of the Academy may, by written petition presented directly to the Council, suggest the name of a person to be nominated to any given post. Any such petition shall be referred by the secretary to the Nominating Committee for its comments. Not less than sixty days prior to the opening of the annual meeting, the Nominating Committee shall report to the Council the Committee's list of nominations, together with its comments on any suggestions made by petition. Not less than forty-five days prior to the opening of the annual meeting, the Council, after considering the Committee's report and any suggestions made by petition, shall nominate one person for each post to be filled. The secretary shall promptly submit this list of nominations to the members of the Academy for voting by unsigned, confidential mail ballots, each such ballot to contain a provision for write-in votes. The elections shall be determined by the ballots received not less

than fourteen days prior to the opening of the annual meeting. After expiration of the time specified for receiving the ballots, the secretary shall open the ballots and tabulate the results, which shall be announced at the annual meeting.

SECTION 5. *Project Committee.* There shall be a Project Committee composed of not less than ten nor more than twenty members appointed by the president, which shall recommend the initiation of studies and organization of symposia and conferences by the Academy, shall review requests for studies and investigations and recommend to the Council suitable action on each, and shall perform such other duties in connection with the programs of the Academy as the Council may direct. The members of the Committee shall be appointed for terms of three years, each of which, as nearly as possible, shall be on a staggered basis.

SECTION 6. *Other Committees.* The Council or the president may appoint such other committees, composed of members of the Academy or nonmembers, or both, as shall be deemed appropriate to carry out the purposes of the Academy and shall define the function and authority of each committee, within the limitation of this Article VII.

SECTION 7. *General.* Except as otherwise provided in these bylaws, any committee may, in the discretion of its chairman, conduct any of its affairs by mail, telephonic, or telegraphic vote of all the members of such committee, provided that any question so decided shall first have been transmitted to every member of the committee in the same wording. An affirmative vote of a majority of the committee shall be necessary for action, and all members of the committee shall be apprised of the vote before the chairman of the committee records the result of the poll on the question so submitted.

A majority of the members of a committee shall constitute a quorum at all meetings thereof.

ARTICLE VIII REPORTS AND PUBLICATIONS

SECTION 1. *Annual Report.* After the close of each fiscal year, the secretary shall prepare an annual report containing a record of the activities of the Academy during that fiscal year, including a copy of the treasurer's report. After approval by the Council, this report shall be transmitted to the president of the National Academy of Sciences and shall be transmitted to the members of the National Academy of Engineering at the annual meeting next following.

SECTION 2. *Other Reports and Publications.* The Academy may arrange for the issuance of such other reports and publications as may be desirable.

ARTICLE IX AMENDMENTS

Amendments to these bylaws may be made only by the members of the Academy by action taken at any stated or special meeting by a majority of the votes cast, provided that the amendment has been proposed by resolution adopted at a previous meeting of the Academy, by resolution adopted by the Council, or by written proposal signed by forty members of the Academy; and provided also that notice of the proposed amendment has been sent to all members of the Academy not less than thirty days prior to the meeting at which the amendment is presented for action.

ARTICLE X PARLIAMENTARY PROCEDURE

The rules contained in *Robert's Rules of Order* shall govern the Academy in all cases to which they are applicable and in which they are not inconsistent with the bylaws or the special rules of order of this Academy.